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ONTARIO SOIL, WATER AND AIR RESEARCH AND SERVICES COMMITTEE

2000 ANNUAL REPORT TO

ONTARIO AGRICULTURAL SERVICES COORDINATING COMMITTEE

JANUARY 26, 2001

102-05334/

ONTARIO SOIL, WATER AND AIR RESEARCH AND SERVICES COMMITTEE

2000 ANNUAL REPORT

Prepared by

Keith Reid, Chair, OSWARSC
Ivan O'Halloran, Vice-Chair, OSWARSC

with assistance from
Paul Brine, OMAFRA Research Analyst

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EXECUTIVE SUMMARY

The 2000 OSWARSC Report is a summary of progress in the third year of our four year strategic plan, as well as a description of any new or revised research priorities. The report will be relatively brief, in keeping with the stage in the OASCC cycle. Summaries of the previous research recommendations are included, but the reader is referred to the 1999 report for the full text of these recommendations.

Research priorities for 2000 are again grouped according to the following Issues, listed in order:

1.Manure Manage ment
2.Nutrient Use Ef ficiency
3.Water Manag ement
4.Soil and Crop Management
5.Id entification / Validation of Best Management Practices
6.Biosoli d / Waste Application and Treatment
7.G reenhouse Gas Emissions

The most visible issue in the past year has been water quality, after contamination of the municipal water system in the town of Walkerton resulted in seven deaths and over 2000 cases of illness. While this was a graphic reminder of the importance of understanding the processes controlling the movement of pathogens into surface and groundwater, it does not alter the order of priority of the issues identified by OSWARC. In fact, the issues surrounding Walkerton touch on all of the issues identified, with the possible exception of Greenhouse Gas Emissions.

New research priorities identified by the three subcommittees reporting to OSWARSC are:

- Priority 1-1: Addition of discussion about preferential flow of contaminants, particularly liquid manure, through soil macropores.
- Priority 2-1: Research concerning optimum rates of nutrients for crop production needs to be tied into the development of nutrient management plans, particularly in light of the development of provincial standards for nutrient management.
- Priority 3-1: Work needs to be done on defining transport pathways to both ground and surface water of nutrients, pesticides and bacteria, so that effective management systems to minimize such movement can be developed.
- Priority 3-2: Research needs to be done on the farm water cycle, to quantify the partitioning of water between runoff, evapotranspiration, drainage through tiles and deep drainage.
- Priority 4-4: Models need to be developed of crop growth and pest development for the purposes of improving Integrated Pest Management and Irrigation Management.

OSWARSC State of the Industry Report

1.Major ac complishments in the past year

A significant accomplishment in the past year is the integration of land resource data for eastern Ontario at ECORC. This initiative comes after several years of minimal effort in the area of land resource information management. The first stage of this project integrates the land resource information from three counties (Stormont, Dundas and Glengarry; Prescott and Russell; Leeds and Grenville) and the Regional Municipality of Ottawa-Carleton, and places it in an electronic database format. With the development of standards and a system for database management, the foundation is laid for extending the soils information system across the province, and the country as a whole. The management of ECORC-AAFC are to be commended for their foresight and initiative in beginning this project.

Another significant accomplishment for the OSWARSC system was the renewal of the water committee. Under the leadership of Dr. Gary Parkin, there has been an increased representation from the agricultural industry. This has allowed a much clearer view of the research priorities concerning water quality and water quantity.

Research is on-going under many of the priorities identified in past reports, but to date have produced small incremental additions to our knowledge base rather than ground-breaking results. A heartening development is the hiring of three new professors at the University of Guelph with an interest in soil management: Bill Deen in the Department of Plant Agriculture, and John Lauzon and Richard Heck in the Department of Land Resource Science. These individuals all replace individuals who have vacated their positions in the past three years.

Research activity is described in more detail in the Issue Champion reports, included elsewhere in this report.

2.State of the Industry

The highest profile incident in the past year related to soil, water and air resources was the contamination of the municipal water system in Walkerton with E. coli 0157:H7 and campylobacter. This single incident has focused the attention of the entire province on the fragility of our water resource if it is not carefully managed. It would be easiest to blame Walkerton on a single factor, while it was actually the unfortunate combination of several factors: heavy rainfall, cattle with the offending bacteria in their manure, inadequate wellhead protection, broken chlorination equipment, and failure to heed water testing results. One thing that Walkerton has pointed out is that there is still much to learn about the pathways that contaminants can follow into ground and surface water.

A less dramatic, but nonetheless important trend is the continuing loss of productive farmland to urban expansion. This is most evident near major urban centers, where both subdivisions and single rural residences are showing huge increases, while small towns are stagnant. This represents a severe competition for the limited land resources, and is most heavily concentrated on the best agricultural land.

Another aspect of the same pattern is the conflict between rural non-farm residents and expanding farm operations. While separation between large farm operations and other residences is the most effective way of reducing complaints, the past policies of allowing severances in agricultural areas have limited the areas where expansion of agricultural operations without impinging on one or more neighbours. The proximity of rural and agricultural landowners also leads to competition for limited water resources.

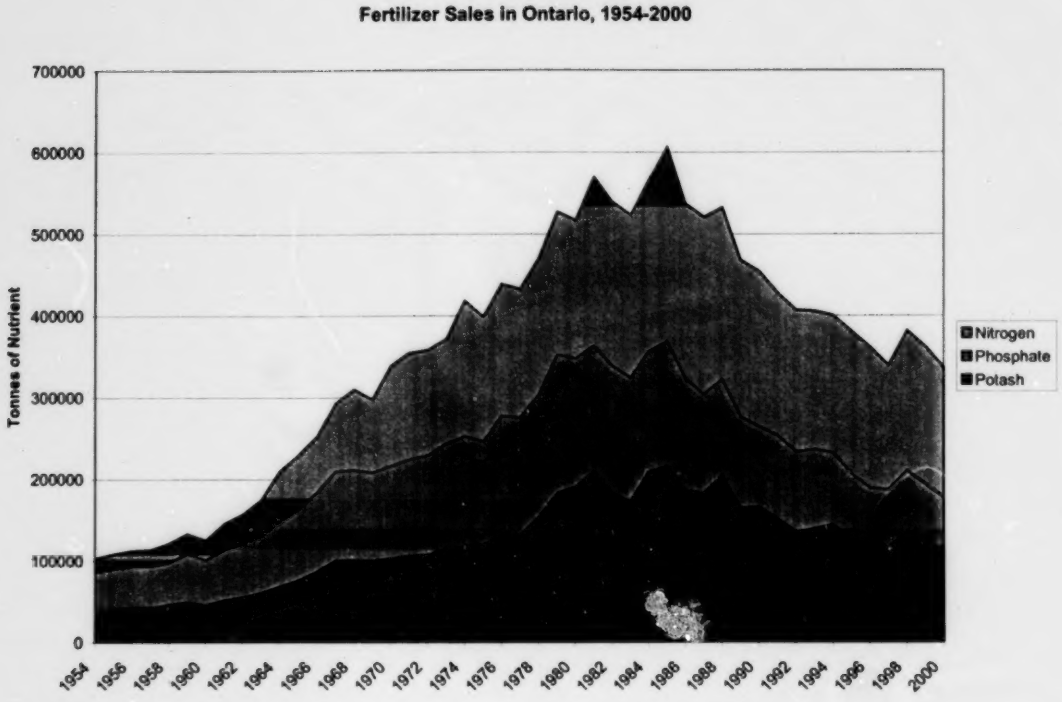
These conflicts for land, water and air resources will, if not resolved, seriously threaten the viability of production agriculture in Ontario, and the quality of life for rural residents. Productive farmland is a non-renewable resource, and once it is lost it cannot be easily replaced. Just as critical as maintaining the total acreage of farmland, however, is maintaining areas where reasonable expansion and modernization of agricultural operations is not precluded by conflicts with neighbours.

Considerable progress has been made in elucidating the current state of knowledge about greenhouse gas emissions from agricultural sources, and the potential for changes in agricultural management to reduce those emissions. Unfortunately, the uncertainty in the emission estimates has not been addressed, and there is a real danger that recommended management changes will not have the desired effect. Moreover, the production of the main greenhouse gases in agriculture (carbon dioxide, methane and nitrous oxide) is inter-related, and the net effect on GHG emissions of any change is not often clear.

Fertilizer sales in 2000 were at the lowest level, when expressed as nutrients sold, since 1969. This reflects, in part, the poor spring weather conditions, as well as the shift in the mix of crops grown on Ontario farms. A summary of the nutrients sold in Ontario since 1954 is shown in the following chart.

Yields of corn, soybeans, and other warm season crops were reduced in 2000 because of cool, wet conditions in many areas. Cereal and forage yields were generally above average, but with these crops the weather conditions caused problems with reduced quality. Compounding the problems of reduced yield and quality were low prices for most agricultural commodities. These prices have been gradually declining for the past three years, but the impact was reduced in 1998 and '99 by above average crop yields.

The net effect has been that the profitability of many cash crop operations is at historically low levels. Income support programs such as Market Revenue are useful, but the actual payment to the farmers does not occur for a year or more, leaving a significant gap in cash flow. Compounding this are sharply increased energy and fertilizer prices for the coming spring. A gradual firming of grain prices is helping to reduce some pressure, but there will be many farmers who come under close scrutiny from their lenders this winter.



Of great concern to OSWARSC is the impending demise of the Environmental Farm Plan program. This program has made great strides in raising the awareness about the role of agriculture in environmental management, but it has been existing on soft money from program to program. Despite the value of the program, it appears that it does not fit the criteria for any of the existing programs. It would be a shame if this program were allowed to disappear for lack of consistent funding.

3.Em erging Issues

Most of the research issues identified this year were extensions of previously identified issues, rather than new issues. The developments over the past year, however, suggest that it might be useful to combine several of the research priorities that have been identified into a few research thrusts. This would allow better co-ordination of projects and a clearer definition of the goals of the research. The suggestions from the group as the OSWARSC annual meeting for these possible Research Thrusts were as follows:

1.S ystem Comparison of Liquid/Solid manure handling
2.Transport Pathwa ys of Nutrients/Bacteria
3.I mpact of manure treatments/handling on GHG emissions
4.L arge vs. small operations

These thrusts cut across the mandates of the Plants, Natural Resources, Rural, and Economics programs, containing aspects of each of these programs. The combination of priorities that are reflected in these suggested thrusts address many of the current concerns surrounding the impact of agriculture on water quality and quality of life.

These research thrusts also tie in with the development of legislation to control the application of nutrients on agricultural land.

One issue that is taking on additional importance is the modeling of pest development in relation to weather conditions. A new fungicide for fusarium control in wheat (Folicur) received temporary registration for 2000, on the basis that an IPM program was in place. This IPM program was to include a model of the risk of fusarium infection, based on current and predicted weather. It is likely that this is only the first such registration. As more products require accurate weather measurement and prediction, the holes in the existing weather recording system will become more and more evident.

INDUSTRY / SECTOR SCAN

New Research Priorities

Priority 1-1: **Development of better manure and biosolid application systems to improve nutrient efficiency and reduce the impacts on environmental quality**

ISSUE: **MANURE MANAGEMENT; NUTRIENT USE EFFICIENCY**

SOURCE: Ontario Soil Management Research & Services Committee

OASCC LINKAGES: Animal Research and Services Committee
Field Crops Research and Services Committee
Engineering Research and Services Committee

TARGET AGENCY: Ontario Ministry of Agriculture, Food and Rural Affairs
Agriculture and Agri-Food Canada, Eastern Region
University of Guelph
Agricultural Research Institute of Ontario
Canadian Agri-Food Research Council

An additional aspect of this priority that needs to be added is research into the preferential flow of manure through soil macro-pores. Movement of liquid manure into tiles through macro-pores has been documented, and this can result in the direct transmission of nutrients and bacteria into surface water. There is little information about the impact of application rate on preferential flow, or on management techniques to minimize or eliminate preferential flow to tiles.

Priority 2-1: **Improving NPK fertility management of corn, cereal crops, canola, horticultural crops and tobacco for increased yield, quality and profitability, and reduced environmental impact.**

ISSUE: **NUTRIENT USE EFFICIENCY**

SOURCE: **Ontario Soil Management Research & Services Committee**

OASCC LINKAGES: Field Crops Research & Services Committee
Horticultural Crops Research & Services Committee

TARGET AGENCY: Ontario Ministry of Agriculture, Food and Rural Affairs
Agriculture and Agri-Food Canada, Eastern Region
University of Guelph
Agricultural Research Institute of Ontario

This research priority needs to be tied into the development of Nutrient Management Plans (NMP's), particularly as they move from being a recommended to a mandated practice. Many of the horticultural crops, for example, lack any data on the nutrients taken up by the crop or removed with the harvested portion, yet this data is necessary if nutrient application is going to be limited in some circumstances to crop removal. The measurement of impact on soil levels of nutrients should become a matter of course for any fertilizer trials.

Priority 3-1: **Defining transport pathways to ground and surface waters for Pesticides, Nutrients and Bacteria.**

"NEW PRIORITY"

ISSUE: **WATER MANAGEMENT**

SOURCE: Ontario Water Management Research & Services Committee

OASCC LINKAGES: Animal Research & Services Committee
Field Crops Research & Services Committee

TARGET AGENCY: Ontario Ministry of Agriculture, Food and Rural Affairs
Agriculture and Agri-Food Canada, Eastern Region
Agricultural Research Institute of Ontario

Background:

It is well known that contaminants can show up in shallow aquifers, but the exact pathways that these contaminants follow are not known. To quantify the movement of contaminants with various properties into groundwater or tile lines, it is critical to understand what pathways they follow. With this understanding, it will be possible to design effective management systems to minimize the movement of contaminants through the soil profile.

Priority 3-2: **To quantify a Farm Water Cycle.**

"NEW PRIORITY"

ISSUE: **WATER MANAGEMENT**

SOURCE: Ontario Water Management Research and Services Committee

OASCC LINKAGES: Engineering Research and Services Committee

TARGET AGENCY: Ontario Ministry of Agriculture, Food and Rural Affairs
Agriculture and Agri-Food Canada, Eastern Region;
Agricultural Research Institute of Ontario

Background:

An understanding of the movement of water through the various farming systems is critical in developing policies for water management. The water budget can be separated into three components:

1.par titioning/budgeting

This includes the partitioning of precipitation between runoff and infiltration, and the division of the infiltration between evaporation, crop uptake and transpiration, drainage through tiles, and deep drainage.

2.irrigation mana gement

Research is needed into the accurate prediction of irrigation requirements, as well as the partitioning of the applied water, the same as for precipitation.

3.competition/sharing

As demands for both surface and groundwater increase for urban, rural non-farm and agricultural uses, an understanding of the competition between these various uses and the impacts on water quantity and quality are critical.

Along with this, it is important to quantify the amount of water available for use in rural communities. This can be derived from existing data for surface water sources, but would require great effort to map the extent and pumping capacities of our underground aquifers.

Priority 4-4: **Modeling for Integrated Pest Management (pest development, optimum treatment timing), Crop Growth, Irrigation Management**

ISSUE: SOIL AND CROP MANAGEMENT

SOURCE: Ontario Agro-meteorology Research & Services Committee

OASCC LINKAGES: Field Crops Research & Services Committee
Horticultural Crops Research & Services Committee

TARGET AGENCY: Ontario Ministry of Agriculture, Food and Rural Affairs
Agriculture and Agri-Food Canada, Eastern Region
University of Guelph
Agricultural Research Institute of Ontario

Background:

Development of models, based on real time weather data, for IPM, crop growth, and irrigation management will go a long way towards increasing the efficiency of crop production and reduce the unnecessary use of pesticides. This will both increase net farm income and reduce the potential impact on the environment.

A caveat to this is that these models will not work without a reliable weather data acquisition network covering all of the important production areas of the province. Gaps in our weather data network have been an ongoing concern, but take on new importance with the development of these management tools.

ISSUES AND PRIORITIES

Background information concerning these research issues and priorities can be found in the 1999 OSWARSC Annual Report.

INFRASTRUCTURE ISSUES

OSWARSC identified a number of infrastructure issues in 1998 which cut across many of the 7 Priority Research Issues around which the 1998 OSWARSC priorities were organized and which must be properly addressed in order to implement the research priorities.

DATA COLLECTION, UPGRADE, MANAGEMENT AND DELIVERY

1) SOIL

Priority #I-A1: **To establish a provincial institute composed of MNR, OMAFRA, AAFC and Land Resource Science Dept., University of Guelph, to be responsible for the integrity of soil resource information for Ontario, and having a mandate to improve the quality of the soil resource information database through a program of soil research and data collection, management, analysis and transfer, to a level sufficient for the preparation of official plans, designation of significant/sensitive lands (e.g. prime agricultural lands; prime wetlands; degraded lands; lands posing risk to water quality), and other basic land use planning activities.**

ISSUE: **DATA COLLECTION AND MANAGEMENT**

SOURCE: **Ontario Soil, Water and Air Research & Services Committee**

OASCC LINKAGES:

TARGET AGENCY: Ontario Ministry of Agriculture, Food and Rural Affairs
Agriculture and Agri-Food Canada, Eastern Region
Ontario Ministry of Natural Resources
University of Guelph
Agricultural Research Institute of Ontario
Canadian Agri-Food Research Council

2) WATER

Priority #I-B1: **Develop an agricultural water management data bank.**

ISSUE: **DATA COLLECTION AND MANAGEMENT**

SOURCE: Ontario Water Management Research & Services Committee

OASCC LINKAGES: Engineering Research and Services Committee

TARGET AGENCY: Ontario Ministry of Agriculture, Food and Rural Affairs
Agriculture and Agri-Food Canada, Eastern Region
University of Guelph
Agricultural Research Institute of Ontario
Ontario Ministry of the Environment
Ontario Ministry of Natural Resources
Canadian Agri-Food Research Council

3) AIR

Priority #I-C1: **Maintain and improve the quality and availability of weather data in Ontario.**

ISSUE: **DATA COLLECTION AND MANAGEMENT**

SOURCE: Ontario Agrometeorology Research & Services Committee

OASCC LINKAGES: Field Crops Research and Services Committee
Horticulture Research and Services Committee

TARGET AGENCY: Ontario Ministry of Agriculture, Food and Rural Affairs
Agriculture and Agri-Food Canada, Eastern Region
University of Guelph
Agricultural Research Institute of Ontario
Environment Canada

***Priority II-1*:** **To develop methodology to evaluate the effect of scale (mapping and spatial) on the quantification and management of soil and water resources.**

ISSUE: **SCALING OF DATA**
EVALUATION OF BEST MANAGEMENT PRACTICES

SOURCE: Ontario Water Management Research and Services Committee

OASCC LINKAGES:

TARGET AGENCY: Ontario Ministry of Agriculture, Food and Rural Affairs
Agriculture and Agri-Food Canada, Eastern Region
University of Guelph
Agricultural Research Institute of Ontario
Canadian Agri-Food Research Council

RESEARCH

Priority 1-1: **Development of better manure and biosolid application systems to improve nutrient efficiency and reduce the impacts on environmental quality**

ISSUE: **MANURE MANAGEMENT; NUTRIENT USE EFFICIENCY**

SOURCE: Ontario Soil Management Research & Services Committee

OASCC LINKAGES: Animal Research and Services Committee
Field Crops Research and Services Committee
Engineering Research and Services Committee

TARGET AGENCY: Ontario Ministry of Agriculture, Food and Rural Affairs
Agriculture and Agri-Food Canada, Eastern Region
University of Guelph
Agricultural Research Institute of Ontario
Canadian Agri-Food Research Council

An additional aspect of this priority that needs to be added is research into the preferential flow of manure through soil macro-pores. Movement of liquid manure into tiles through macro-pores has been documented, and this can result in the direct transmission of nutrients and bacteria into surface water. There is little information about the impact of application rate on preferential flow, or on management techniques to minimize or eliminate preferential flow to tiles.

Priority 1-2: **Determine the best methods to evaluate the effectiveness of manure treatment technologies, and to develop protocols for evaluating treatment technologies including on-site testing for odours.**

ISSUE: **MANURE MANAGEMENT**

SOURCE: Ontario Soil Management Research & Services Committee

OASCC LINKAGES: Animal Research & Services Committee (ARSC)

TARGET AGENCY: Ontario Ministry of Agriculture, Food and Rural Affairs
Agriculture and Agri-Food Canada, Eastern Region
University of Guelph
Agricultural Research Institute of Ontario
Canadian Agri-Food Research Council

Priority 1-3: **Identification of Sources of Surface Water Contaminants**

ISSUE: **MANURE MANAGEMENT; WATER MANAGEMENT**

SOURCE: **Ontario Soil Management Research & Services Committee**

OASCC LINKAGES: Animal Research & Services Committee
Engineering Research and Services Committee
Rural Community Development Research & Services Committee

TARGET AGENCY: Ontario Ministry of Agriculture, Food and Rural Affairs
Agriculture and Agri-Food Canada, Eastern Region
University of Guelph
Agricultural Research Institute of Ontario
Ontario Ministry of the Environment
Ontario Ministry of Health

Priority 2-1: **Improving NPK fertility management of corn, cereal crops, canola, horticultural crops and tobacco for increased yield, quality and profitability, and reduced environmental impact.**

ISSUE: **NUTRIENT USE EFFICIENCY**

SOURCE: **Ontario Soil Management Research & Services Committee**

OASCC LINKAGES: Field Crops Research & Services Committee
Horticultural Crops Research & Services Committee

TARGET AGENCY: Ontario Ministry of Agriculture, Food and Rural Affairs
Agriculture and Agri-Food Canada, Eastern Region
University of Guelph
Agricultural Research Institute of Ontario

This research priority needs to be tied into the development of Nutrient Management Plans (NMP's), particularly as they move from being a recommended to a mandated practice. Many of the horticultural crops, for example, lack any data on the nutrients taken up by the crop or removed with the harvested portion, yet this data is necessary if nutrient application is going to be limited in some circumstances to crop removal. The measurement of impact on soil levels of nutrients should become a matter of course for any fertilizer trials.

Priority 3-1: **Defining transport pathways to ground and surface waters for Pesticides, Nutrients and Bacteria.**

"NEW PRIORITY"

ISSUE: **WATER MANAGEMENT**

SOURCE: Ontario Water Management Research & Services Committee

OASCC LINKAGES: Animal Research & Services Committee
Field Crops Research & Services Committee

TARGET AGENCY: Ontario Ministry of Agriculture, Food and Rural Affairs
Agriculture and Agri-Food Canada, Eastern Region
Agricultural Research Institute of Ontario

Background:

It is well known that contaminants can show up in shallow aquifers, but the exact pathways that these contaminants follow are not known. To quantify the movement of contaminants with various properties into groundwater or tile lines, it is critical to understand what pathways they follow. With this understanding, it will be possible to design effective management systems to minimize the movement of contaminants through the soil profile.

Priority 3-2: **To quantify a Farm Water Cycle.**

"NEW PRIORITY"

ISSUE: **WATER MANAGEMENT**

SOURCE: Ontario Water Management Research and Services Committee

OASCC LINKAGES: Engineering Research and Services Committee

TARGET AGENCY: Ontario Ministry of Agriculture, Food and Rural Affairs
Agriculture and Agri-Food Canada, Eastern Region;
Agricultural Research Institute of Ontario

Background:

An understanding of the movement of water through the various farming systems is critical in developing policies for water management. The water budget can be separated into three components:

1.par titioning/budgeting

This includes the partitioning of precipitation between runoff and infiltration, and the division of the infiltration between evaporation, crop uptake and transpiration, drainage through tiles, and deep drainage.

2.irrigation mana gement

Research is needed into the accurate prediction of irrigation requirements, as well as the partitioning of the applied water, the same as for precipitation.

3.competition/sharing

As demands for both surface and groundwater increase for urban, rural non-farm and agricultural uses, an understanding of the competition between these various uses and the impacts on water quantity and quality are critical.

Priority 3-3: **Determining the Optimal Type, Width and Management of Riparian Buffer Strips to Reduce Sediment, Nutrient and Pesticide Loss into Watercourses**

ISSUE: **WATER MANAGEMENT**

SOURCE: Ontario Soil Management Research & Services Committee

OASCC LINKAGES: Animal Research & Services Committee
Field Crops Research & Services Committee

TARGET AGENCY: Ontario Ministry of Agriculture, Food and Rural Affairs
Agriculture and Agri-Food Canada, Eastern Region
Agricultural Research Institute of Ontario
Ontario Ministry of Natural Resources

Priority 3-4: **To quantify water quality functions for Ontario wetlands.**

ISSUE: **WATER MANAGEMENT**

SOURCE: Ontario Water Management Research and Services Committee

OASCC LINKAGES: Engineering Research and Services Committee

TARGET AGENCY: Ontario Ministry of Agriculture, Food and Rural Affairs
Agriculture and Agri-Food Canada, Eastern Region;
Agricultural Research Institute of Ontario
Ontario Ministry of the Environment
Ontario Ministry of Natural Resources

Priority 4-1: **Improving the management, productivity and profitability of field crop production by increasing our understanding of temporal and spatial variability of soil properties in agricultural fields.**

ISSUE: **SOIL AND CROP MANAGEMENT**
NUTRIENT USE EFFICIENCY

SOURCE: Ontario Soil Management Research & Services Committee

OASCC LINKAGES: Field Crops Research & Services Committee
Horticultural Crops Research & Services Committee

TARGET AGENCY: Ontario Ministry of Agriculture, Food and Rural Affairs
Agriculture and Agri-Food Canada, Eastern Region
University of Guelph
Agricultural Research Institute of Ontario

Priority 4-2: **Developing crop rotation systems to enhance soil quality and improve crop productivity**

1) Maximizing Yields Under a Short Term Soybean Rotation
2) Crop Rotation and Sequence Effects on Soil
3) Cover Crops in Horticultural Systems

ISSUE: **SOIL AND CROP MANAGEMENT**

SOURCE: Ontario Soil Management Research & Services Committee

OASCC LINKAGES: Field Crops Research & Services Committee
Horticulture Research & Services Committee

TARGET AGENCY: Ontario Ministry of Agriculture, Food and Rural Affairs
Agriculture and Agri-Food Canada, Eastern Region
University of Guelph
Agricultural Research Institute of Ontario

Priority 4-3: **Overcoming factors limiting crop production when growing no-till corn and horticultural crops**

1) Fine Tuning No-till Systems
2) Managing Wheat Residue
3) Lime application:
4) Reduced Tillage Systems for Vegetable Production

ISSUE: **SOIL AND CROP MANAGEMENT**

SOURCE: Ontario Soil Management Research & Services Committee

OASCC LINKAGES: Field Crops Research & Services Committee
Horticultural Crops Research & Services Committee

TARGET AGENCY: Ontario Ministry of Agriculture, Food and Rural Affairs
Agriculture and Agri-Food Canada, Eastern Region
University of Guelph
Agricultural Research Institute of Ontario

Priority 4-4: **Modeling for Integrated Pest Management (pest development, optimum treatment timing), Crop Growth, Irrigation Management**

ISSUE: **SOIL AND CROP MANAGEMENT**

SOURCE: Ontario Agro-meteorology Research & Services Committee

OASCC LINKAGES: Field Crops Research & Services Committee
Horticultural Crops Research & Services Committee

TARGET AGENCY: Ontario Ministry of Agriculture, Food and Rural Affairs
Agriculture and Agri-Food Canada, Eastern Region
University of Guelph
Agricultural Research Institute of Ontario

Background:

Development of models, based on real time weather data, for IPM, crop growth, and irrigation management will go a long way towards increasing the efficiency of crop production and reduce the unnecessary use of pesticides. This will both increase net farm income and reduce the potential impact on the environment.

Priority 5-1: **To quantify the effectiveness of various Best Management Practices that are being recommended and implemented by the farm sector to reduce and/or control contamination of surface and ground water resources by agricultural fertilizers (organic and inorganic), pesticides, and sediments.**

ISSUE: **EVALUATION OF BEST MANAGEMENT PRACTICES; NUTRIENT USE EFFICIENCY; WATER MANAGEMENT**

SOURCE: Ontario Water Management Research and Services Committee

OASCC LINKAGES: Field Crops Research & Services Committee
Horticultural Crops Research & Services Committee

TARGET AGENCY: Ontario Ministry of Agriculture, Food and Rural Affairs
Agriculture and Agri-Food Canada, Eastern Region;
Agricultural Research Institute of Ontario

Priority 5-2: **Development of techniques, practices and amendments that improve water management on fine-textured soils.**

ISSUE: **EVALUATION OF BEST MANAGEMENT PRACTICES; WATER MANAGEMENT**

SOURCE: Ontario Water Management Research and Services Committee

OASCC LINKAGES: Field Crops Research & Services Committee
Horticultural Crops Research & Services Committee

TARGET AGENCY: Ontario Ministry of Agriculture, Food and Rural Affair
Agriculture and Agri-Food Canada, Eastern Region
Agricultural Research Institute of Ontario

Priority 6-1: **To conduct research to quantify short and long-term effects (positive and negative) of land application of biosolids, towards the development of application protocols based on their properties**

ISSUE: **BIOSOLID / WASTE APPLICATION AND TREATMENT**

SOURCE: Biosolids Issue Champion

OASCC LINKAGES: Field Crops Research & Services Committee
Horticulture Research & Services Committee
Engineering Research & Services Committee
Rural Community Development Research & Services Committee

TARGET AGENCY: Ontario Ministry of Agriculture, Food and Rural Affairs
Ontario Ministry of the Environment
Ontario Ministry of Health
Agriculture and Agri-Food Canada, Eastern Region
Agricultural Research Institute of Ontario
Canadian Agri-Food Research Council

Priority 6-2: **To develop practical remedial techniques for managing environmental impacts of existing contamination, and evaluating their economic feasibility.**

ISSUE: **BIOSOLID / WASTE APPLICATION AND TREATMENT**
WATER MANAGEMENT; MANURE MANAGEMENT

SOURCE: Ontario Water Management Research and Services Committee

OASCC LINKAGES: Animal Research and Services Committee
Engineering Research and Services Committee
Economics Research and Services Committee

TARGET AGENCY: Ontario Ministry of Agriculture, Food and Rural Affairs
Agriculture and Agri-Food Canada, Eastern Region
Agricultural Research Institute of Ontario
Ontario Ministry of the Environment

Priority 7-1: **To continue to support the measurement and modelling of greenhouse (trace) gases, and to continue the association of this work with research on management systems for nitrogen and organic wastes.**

ISSUE: **GREENHOUSE GAS EMISSIONS**

SOURCE: Ontario Agrometeorology Research And Services Committee

OASCC LINKAGES: Field Crops Research & Services Committee
Animal Research & Services Committee
Horticulture Research & Services Committee
Engineering Research & Services Committee

TARGET AGENCY: Ontario Ministry of Agriculture, Food and Rural Affairs
Agriculture and Agri-Food Canada, Eastern Region
University of Guelph
Agricultural Research Institute of Ontario
Canadian Agri-Food Research Council
Environment Canada

APPENDIX I

Sub-Committee Reports

Ontario Agrometeorology Research and Services Committee

Ontario Soil Management Research and Services Committee

Agrometeorology Research and Services Committee

Minutes of the meeting November 7, 2000
Room 441 University Centre, University of Guelph

Present
Chair: Alan McKeown, U. of Guelph
Tom Jewett, Agriculture and Agrifood Canada
Ian Nichols, Ridgetown College
Ron Pitblado, Ridgetown College
Heather Griffiths, OMAFRA,
Diane Harvey, Ont. Grape Marketing Board,
Terry Gillespe, U of Guelph,
Jon Warland , U of Guelph
Chis Marshall, Environment Canada
Randy Mawson, Environment Canada

Regrets:
Henry Hayhoe

Reports

Written reports were presented by Tom Jewett, Ian Nichols, Diane Harvey, Randy Mason/Chris Marshall, Terry Gillespie, Alan McKeown and are attached.

Most of the discussion centred around autostation and IPM /weather service issues. Two organizations have been created to supply weather data services to growers in the Southwest (Ontario Weather Network, OWN run at Ridgetown College) and the grape industry (Niagara Weather Network , NAWN) in cooperation with Brock, Guelph, OMAFRA. Environment Canada (Meteorological Service of Canada) also runs a fee for service Agricultural weather forecast service. There are at least three levels of needs for data, a wide area, regional, eg Niagara and local including on farm. Different types of autostations can be used for each of these depending on needs and price. Each use has somewhat different needs for data. Wide area data is required for forecasts, real time data for operational scheduling and more local for IPM, irrigation depending on the crop and the needs of the individual client. Depending on use, there are gaps in the data available. A number of corporations or Ministries have weather stations of various types. MTO has roadside and embedded sensors to monitor weather along certain roads. AES collects, processes and returns the data for a fee.

Various models for IPM, irrigation etc have been developed in a number of areas. There is a need to compile and verify/validate and develop new models as required for IPM, water use, nutrient management purposes. Considerable discussion occurred on weather station maintenance and costs, sources of funds, sensor calibration, cost of web pages for delivery, availability of data, suitable models. These are common problems at all sites irregardless of research or service organizations. The above services are fee for service or subscription type services. Cost of service, types needed by clients and the willingness of clients to pay for previously free services was discussed at length.

Public concerns about food safety, pesticide used may drive the agricultural product buyers towards mandatory IPM programs, HACCP or ISO standard like programs before a grower can sell the crop. The Norfolk Fruit growers are now ISO 9000, 14000 certified for this reason to allow them to sell into Europe. Bernie Solymar is working to develop an apple labelling program which includes IPM with the World Wildlife Fund, the apple commission and Sobey's. As well, folicur a recently registered pesticide has IPM mandated on the label. This may be a trend for further registrations. As well, concerns over water will require better irrigation and water management systems based on weather. A functional, accurate, easy to access, cost effective weather data acquisition, processing and distribution system will be necessary to cope with these emerging trends. Lack of such a system will put Ontario farmers at a competitive disadvantage.

No one organization can afford the number of stations required to cover the Province. It is evident that with a number of organizations, government, private companies operating weather stations that a means of sharing, validating processing and distributing data is required. This will require cooperation and a share of revenue from sale of the product. What is required is a "broker" who will cooperate in maintenance, collection, verification, calculation and distribution of the product to users.

Research and Services Priorities

The committee strongly supported all ongoing research and last year's priorities.

Last year's priorities, needs and emerging issues were discussed at length. A number of issues were identified:

Services

- quality of the weather radio network, holes in data and coverage, severe weather broadcasts.
- micro climate issues, especially for Hort crops wrt predictive models, data, reports, distribution to end users.
- look across borders for working models.
- diagnostics for environmental damage.

Research

- develop models for other crops for example:
  - IPM,
  - Irrigation,
  - insects, eg corn borer in peppers,
- not having IPM programs may be barriers to new Pesticide Registration
- -identify, acquire, validate models from other locations. Adapt those suitable and develop models to fill gaps.

Emerging issues carried forward from 1999.

- adapting agricultural production systems to climate change and detecting effects of climate change on crop yields.
- adapting to the Kyoto Agreement
- carbon sequestering by no-till
- air pollution.

New issues in 2000

A new trend in registration of pesticides with a requirement for an IPM program eg Folicur. Weather data is essential to IPM programs and loss of weather services and IPM could result inaccessibility of new chemistry to growers.

IPM programs may be inexpensive selling points for product buyers. There appears to be a trend to mandating IPM and HACCP programs by growers before they can sell to buyers. Wegman's in New York appears to be favouring produce grown under IPM schemes. Reliable weather data, models and IPM programs will be required by growers if they want to sell their products. Lack of a weather based IPM system could result in serious impacts on Ontario Growers to compete or sell their products.

Irrigation scheduling, water use, competition for water, nutrient management will be increasingly important even without Global Warming. Evapotranspiration is the basis of irrigation scheduling models. However, the two models that are used do not agree in Ontario. One works well in the Guelph area, the other works well in Harrow. Outside of these areas results do not agree. Thus in addition to work on scheduling, water use efficacy, work is needed on evapotranspiration models that work across the Province.

2000-1R Continue to support the measurement and modelling of greenhouse gasses (trace gasses), and continue the association of this work with research on management systems for nitrogen and organic wastes. There is a lot of uncertainty in climate change prediction and spatial resolution is not adequate for agriculture. We need to automatically change climate impact analyses so that as the skill in climate forecasting improves, we can update our impact analyses.

2000-2R Continue to support the development and testing of models for: use in applications such as pest/disease management, crop growth models and irrigation scheduling. Models need to be wide area to site specific depending on the needs of the crop and grower.

2000-3R Quantify the impact, benefits and detriments of climate change and how to adapt to climate change. As well quantify the impact, benefits and detriments of the Koyoto Agreement and how to adapt its ramifications.

2000-4R Expand research on diffusion/dispersion modelling in agricultural situations

2000-1S/R Continue to attack the problem of deteriorating quality and availability of weather data in Ontario.

Weather data is a core component of programs to help reduce agricultural impact on the environment and maintain productivity. These include pesticide management and reduction, irrigation scheduling for efficient water usage, minimize leaching surface runoff and soil degradation.

Priorities directed to
OMAFRA, Agriculture and Agrifood Canada, University of Guelph, and Environment Canada Meteorological Service of Canada and Environmental Protection Divisions.

SUMMARY OF AGROMETEOROLOGICAL ACTIVITIES AT THE GUELPH CAMPUS, UNIVERSITY OF GUELPH.

Prepared for the meeting of the Ontario Agrometeorology Research and Services Committee
November 7, 2000.

Overview

Agrometeorology activities at Guelph are focused in the Department of Land Resource Science. Professor George Thurtell has recently retired and been replaced by a new young faculty member, Dr. Jon Warland. George is continuing to assist with our research program, and Professors Claudia Wagner-Riddle and Terry Gillespie also continue as members of the group.

The teaching program continues to support five undergraduate courses in the areas of general meteorology and agrometeorology (2nd year), microclimatology (3rd year), physical meteorology, atmospheric transport and atmospheric chemistry (4th year). The graduate program includes courses in the Physical Environment of Crops and Forests, Agrometeorological Instrumentation and Micrometeorology. The undergraduate program serves about 150 students per year and the graduate program currently has 9 students pursuing M.Sc. or Ph.D. degrees.

Research and service activities are centered on environmental issues associated with climate change and air quality. Brief summaries of the projects underway are given below.

Summaries of Research Activities

Measurements of nitrous oxide and methane fluxes from solid and liquid manure storage facilities. Micrometeorological mass balance methods are being used to determine the contribution of such facilities to the atmospheric budget of climate-warming gases, and to study options for reducing emissions of these gases.

Enhancement of technology to measure trace gas emissions. A system has been developed to measure ammonia fluxes by tunable diode laser spectrometry, using an adaptation of techniques developed earlier for N_2O and methane detection. Also, new theoretical and field techniques are under investigation which will allow fluxes of gases to be determined from the smaller plot sizes that are traditionally used in agricultural research, rather than the much larger plots normally required to provide sufficient fetch for micrometeorological measurements. This work promises to allow fluxes of CO_2 and climate-warming gases to be made from existing long-term tillage and rotation plots, which will be an important contribution to our knowledge of carbon and trace gas budgets.

Studies of hydrocarbon fluxes from contaminated soils. Soils which have been accidentally contaminated by fuel spills, or purposely used as biodegradation sites for oily wastes, have been questioned as potential sources for hydrocarbons which can participate in ground-level smog. Micrometeorological techniques have been used at field sites, and laboratory scale bioreactors have been used to study the fluxes of hydrocarbon from such soils. The general conclusion is that most of the loss of spilled fuel or oily waste results from biodegradation in the soil rather than volatilisation into the atmosphere.

Use of isotope ratios as a potential identifier of sources of hydrocarbons. Hydrocarbons which participate in ground-level smog can be from both vegetative sources and human activities. Often, a particular hydrocarbon comes from either a vegetative or human source, but not both. However, there are a few compounds which appear to come from both sources, notably isoprene, a powerful ozone producer. Control of the biogenic sources is difficult (removal of vegetation often not a good option) while control of human sources may be feasible. Therefore, a way to identify the origin of isoprene by its $^{12}C/^{13}C$ ratio is being investigated.

Impact of climate change on vegetable yields in Ontario. This is a cooperative project between Jon Warland at Guelph and Al McKeown at the Simcoe Research Station. They are studying possible correlations between long-term yield data and the climatic record.

Summaries of Service Activities

Continued efforts to maintain and enhance a weather station network for use in agrometeorology. Major activity is centered at the Ridgetown campus under the direction of Ron Pitblado and Art Schaafsma, with support from the Guelph group. The objective is to obtain transfer of all equipment at ex-OMAFRA weather stations to the University, and to negotiate with the Meteorological Service and/or other possible sources to provide ongoing calibration and maintenance of the stations. A pilot project to disseminate the data, and value-added maps and indices, was carried out at Ridgetown during the past summer.

Various presentations to users of weather information. Members of the Guelph faculty provided instructional sessions or presentations to the turf industry, the winter Farm and Equipment Fair in New Liskeard, and to Certified Crop Consultants.

NIAGARA AGRICULTURAL WEATHER NETWORK (NAWN)

DESCRIPTION:

- A network of 12 automated solar-powered weather recording stations located in various vineyards throughout the Niagara region, which includes both grape and tender fruit growing areas. The stations are linked by modem (connected to the public telephone system) to a two-computer central processing system located at Brock University and which operates 24 hours a day.
- Reports of the information collected are generated on a daily basis, and sent to subscribers daily or weekly via internet or fax. Different reports are compiled depending upon the needs of different subscribers: growers need summary reports and researchers require raw data. Examples of reports are attached.
- Web Site includes access for members/subscribers to view reports.

PURPOSE:

- Created in 1993 by the Ontario Grape Growers' Marketing Board (OGGMB) to develop a long term data base for a micro-climate map of the Niagara region. Within the region, the micro-climates vary considerably depending upon such things as elevation, natural air flow, drainage, proximity to the Lake, etc.
- This would assist in serving as a guide in the selection of preferable sites for planting the appropriate grape varieties.
- Assist growers, wineries, researchers and specialists with information on a variety of weather factors. Examples include: rainfall, temperature, degree-day accumulations (heat units). Assists in the monitoring of crop development, estimation of spray and irrigation schedules as well as harvest times, and provide specific information for integrated disease and pest management controls.

HISTORY:

- A Committee was formed from representatives of the OGGMB, the University of Guelph, and the Ministry of Agriculture, Food, and Rural Affairs (OMAFRA).
- The selection of weather sites by the Committee was based upon the following criteria (map of sites attached):
- Broad representation of the micro-climate zones
- Geographical balance to cover the narrow stretch of land fronting Lake Ontario that encompasses this region (Queenston to Winona; above & below the escarpment)
- Funding of $120,000 received from Grape and Wine Adjustment Program to purchase equipment for NAWN. Later the Rural Job Strategy Fund assisted with costs.
- OMAFRA and Agriculture and Agri-Food Canada staff developed the customized software needs.
- Weather stations were installed in the summer of 1994, with first reports provided to subscribers on April 1, 1996.
- In the spring of 1999, the operation of the network was transferred to the NAWN Consortium (each contribute funds toward ongoing maintenance), a group consisting of representatives from:
- OGGMB
- Ontario Tender Fruit Producers' Marketing Board (OTFPMB)
- OMAFRA
- Guelph University
- Brock University
- Niagara College
- Agriculture and Agri-Food Canada

DESIGN:

- The system is designed to perform several functions simultaneously and independently, except for the sharing of basic data files. Functions are split between two PC's: one collects data ("data PC") and processes it; the other distributes reports ("communicator PC").
- The effectiveness of NAWN is dependent on the collection and storage of data from the reporting stations, and then on its ability to distribute the information in a useful manner and on a reliable basis.

HARDWARE:

Weather Stations include:

- Campbell Scientific CR 10 Measurement and Control Modules
- Storage Battery
- Solar Panel
- Modem
- Public telephone line
- Rain gauge (tipping bucket)
- Sensors for temperature
- Sensors for leaf wetness
- Sensor for relative humidity
- Some have sensors for wind speed and direction, and solar radiation.

Data PC uses an external modem to connect to the logger modems. The communicator PC uses two modems, one for fax and the other for the internet. The computers are linked by Ethernet.

SOFTWARE:

- Commercially written software used wherever possible, and includes: Campbell Scientific (loggers), Clark Development (bulletin board), Microsoft (operating system & networking), Smith Micro Software (fax).
- Custom written software was used to manipulate data and produce reports, as designed by OMAFRA and Agriculture and Agri-Food Canada.

CONCERNS AND DIRECTIONS FOR THE FUTURE:

MODELLING:

- Goal of applying disease and pest management models to the system. At present, the pest management warnings are based upon the old Agriculture Canada bugwatch, which still requires some validation and also applies only to apples. Wendy McFadden-Smith of Uof G/Vineland Station had looked at powdery and downy mildew models, but they were never validated. Also, the Transpiration Model was never utilized as it was not validated.

DATA MANAGEMENT:

- Investigating the possibility of creating an estimation layer of data to counteract data lost due to equipment failure, in order to accurately represent years for future historical comparisons.

FINANCIAL:

- Increase the number of sites by one site per year, over 3 years (provided funds available). Costs for basic station set-up (platform and tower) approximately $8,000.
- Continued financial support for maintenance of the system, as well as upgrades.

Report to the Ontario Agrometeorology Committee.
November 7
Alan McKeown

The wet weather this spring in this area created havoc in Agriculture. At this site our precipitation totalled as follows:

	April	May	June	July	August	September	October
2000	91.2	103	180.8	146	80.6	99.2	28.0
Norm (mm)	83.4	73.8	81.6	76.7	80.1	88.8	73.2

Contrast this to the extreme droughts in the past two years. The climate variability and impact on yields will be an issue as our climate changes. Temperatures have been normal to above normal, especially night temperatures.

Work is ongoing in the apple management and small fruit breeding program on irrigation management. I have been working on weather data to explain the variability in interannual yields of sweet potatoes under our climate. While temperature might be suspected as a major factor for a tropical vegetable a long way from its origin, it appears the total vapour pressure deficit for the growing season is important. A while ago I noticed that if you plot average Ontario yield over time of some cool season vegetables a very interesting trend occurs.

Yields increased from 1941 and dropped in the mid 80's. Yields now are not much higher than in the 40's on average. The question is why? Jon Warland, Myself and Mary Ruth McDonald presented a paper on this at a recent meeting in San Diego. Is interesting to note that the "greenhouse" effect was noticeable in the late 80's. If this is related to the greenhouse effect it has serious implications for our food supply. Other factors could include disease, soil degradation. The relationships to average yield and climate require study for horticultural crops.

11.7

INTERANNUAL VEGETABLE YIELD VARIABILITY IN ONTARIO: IS CLIMATE A FACTOR?

Jon S. Warland, University of Guelph, Guelph, ON N1G 2W1, Canada, Alan W. McKeown, and Mary Ruth McDonald.

Agricultural productivity increased steadily after the last war due to nitrogen fertilizers and management practices. However, horticultural yield data in Ontario from the last few decades shows extreme variability from year to year. Sweet potato yield data shows a correlation with seasonal vapour pressure deficit, with negative correlation for some varieties and positive for others. Therefore we are examining the climate records of Ontario in an effort to establish other correlations between climatic factors and yields of different horticultural crops. This talk will present an analysis of interannual climatic variability in Ontario over the last four decades with particular attention paid to any changes in variability. The analysis will be presented in the context of horticultural yield data. The goal of this work is to identify which varieties thrive under which conditions to better assess climate change adaptation scenarios.

Highlights of Agrometeorological Activities
Eastern Cereal and Oilseed Research Centre
Agriculture and Agri-Food Canada
Ottawa
Henry Hayhoe

1. We have initiated a new study entitled: Agroclimatic Resource Assessment in a changing climate. The objective of the study is to develop methodologies and to carry out agroclimatic resources assessments for current and forecast climate scenarios to identify impacts, opportunities and adaptation strategies. The study leader is Henry N. Hayhoe and the collaborators are Andy Bootsma, Reinder DeJong and David Lapen.

2. We are involved in three studies supported by the Climate Change Action Fund.
   a) Evaluation potential impact of climate change on the risk of winter injury to overwintering crops in Eastern Canada (CCAF collaborative project with Ste-Foy RC)
   b) Evaluation potential impacts of climate change on suitability/capability of Atlantic region to produce corn, soybeans and cereal crops by assessment of appropriate heat and moisture indices (CCAF funded project, lead by Andy Bootsma in collaboration with Canadian Forest Service, Sault Ste. Marie)
   c) Evaluation crop yields under historic and climate change scenario using the EPIC model (CCAF funded project, lead by Reinder DeJong)

Greenhouse and Processing Crops Research Centre
Agriculture and Agri-Food Canada, Harrow, Ontario

2000 Annual Report
to
Ontario Agrometeorology Research and Services Committee
Annual Meeting - November 7, 2000
Room 103, University Centre, University of Guelph

T.J. Jewett

Agrometeorology Activities in 2000:

A Memorandum of Understanding (MOU) was signed by Agriculture and Agri-Food Canada - Greenhouse and Processing Crops Research Centre (AAFC-GPCRC) and Environment Canada - Atmospheric Environment Branch, Ontario Region (EC-OR), to install an extensive Reference Climate Station for the purpose of automated acquisition of climatological weather data at the GPCRC in Harrow. Installation was carried out by EC-OR in early summer. Existing AAFC-GPCRC weather monitoring equipment at Harrow will be phased out over the next 2 years as the EC-OR instrumentation becomes functional. The system at Harrow is linked directly to EC-OR by telephone. Telephone links to OMAFRA will not be available. Daily summaries of the data are available through the AAFC Eastern Cereal and Oilseed Research Centre web site.

The reference climate station at the AAFC-GPCRC, Honourable Eugene F. Whelan Experimental Farm at Woodslee was renovated with a new tilt tower and sensors during the summer. An EC-OR rain gauge will be installed parallel to the existing rain gauge.

Non AAFC-GPCRC requests for weather data increased from 20 in 98-99 to more than 30 in 99-2000. Most external requests came from the Ontario Ministry of Agriculture, Food and Rural Affairs, and municipalities. Seed companies and Agri-outlets are minor users of the AAFC-GPCRC weather data.

To meet Good Laboratory Practice accreditation requirements, procedures are being investigated at the AFFC-GPCRC for traceable calibration and certification of weather instruments to Canadian Services National Institute of Science & Technology (NIST) standards by certified personnel.

The integrated crop production team continued studies at the AAFC-GPCRC, Honourable Eugene F. Whelan Experimental Farm at Woodslee and commercial growers to monitor surface runoff and drainage tile discharge.

The greenhouse research team continued development work on a model to predict leaf surface microclimate in greenhouse crop canopies. A Classification and Regression Tree (CART) model was developed to predict the probability of leaf wetness in greenhouse crop canopies based on inside temperature, relative humidity and height in the canopy, and outside temperature.

Meteorological Service of Canada - Ontario Region
Agrometeorology Services for the 2000 Season

The 2000 season was our 5th year providing commercial weather products in Ontario. We offered two core services to farmers in Ontario this year, and also provided services to a new venture in Southwestern Ontario.

1-900-565-FARM:

For a charge of $0.95/min farmers in Southern Ontario can access the following information, in different "bins" on the farm ATAD (automatic telephone answering device):

- Agricultural forecast for Southwestern and Southeastern Ontario includes information on drying index and provides an estimate of precipitation amounts. Forecast for days 1-2.
- Extended forecast (days 3-5)
- Hourly conditions across the province
- Climate data from previous 24-hours, includes Max/Min Temperature, precipitation, GDDs and CHUs
- Seasonal climate report, provides a seasonal accumulation of precipitation, GDDs and CHUs with a comparison to the previous season
- Commodity information is also loaded by the Farm Market News, which includes a Market Summary, Grain Report, Hog Report, Livestock Report, and Corn Commentary

The bins on the farm ATAD were accessed over 28,000 times this year (up until October 31st), which is about the same volume of calls made in 1999. We also answered numerous calls during the season on our weather One-On-One line, which provides farmers direct access to an Environment Canada weather forecaster for consultation.

Farm Web-Page:

We again offered accounts to access our agricultural web page this season. Subscribers could access a complete suite of information for about $20.00/month (depending on length of subscription). The following information is available on the web-page from April 1st until October 31st (calendar dates):

- Agricultural and Public Forecasts (same as offered on the farm ATAD)
- Current conditions
- Climate data on a daily and seasonal basis
- Real-time radar and satellite imagery
- Access to commodity reports (same as offered on the farm ATAD)
- A 10-day GDD and CHU forecast (new this year)

We have about 25-30 users paying to access this page.

Ontario Weather Network (OWN):

MSC Ontario Region was involved in a new initiative this season. The OWN is located at the University of Guelph's Ridgetown College, and combines the expertise of Researchers such as Dr. Art Schaafsma, with people such as Brian Doidge (Farm Market News) and Ian Nichols (OWN Project Manager) who deliver information to producers.

Their goal is to collect data from a network of weather stations across Southern Ontario in real-time, centrally archive this data, and then produce field specific products to assist in crop management decisions. Integrated pest management is at the heart of this initiative.

Environment Canada realizes the potential for Integrated Pest Management forecasts and was glad to assist in this pilot project with the goal of a longer-term relationship in this field by providing the following data:

- Archived hourly conditions from 23 sites (delivered once per 24 hours)
- A 10-day temperature forecast for 8 sites
- An hourly forecast for the next 38 hours of temperature and dew point
- Numeric Radar data from Exeter in real-time in ASCII format
- 12-hour precipitation estimates from Exeter in GIF format, with plan to include real-time numeric files in the future.

This data was utilized as input to various IPM models. The data requirements for next season have yet to be worked out, and will depend on the success of the OWN to implement the early stages of their network.

MSC will continue to work closely with OWN in developing a workable strategy for integrated pest management within our resource management.

ONTARIO SOIL MANAGEMENT

RESEARCH AND SERVICES COMMITTEE

2000 REPORT TO

ONTARIO SOIL, WATER AND AIR RESEARCH SERVICES COMMITTEE

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New Research Recommendations
Complete Prioritised Listing of 2000 Research Recommendations
Minutes of 2000 Annual Meeting

Executive Summary

The annual meeting of the Ontario Soil Management Research and Services Committee (OSMRSC) was held at ECORC, AAFC, Ottawa on June 6 and 7, 2000. Members presented various subcommittee reports outlining suggested changes to OMAFRA Publications pertaining to field crop production and horticultural crop production, as well as old and new research issues. The Soil & Water subcommittee expressed the need for the development of a N index to deal with the risk of nitrate leaching. The committee was informed that such a project was currently being worked on by LRS and OMAFRA under OASCC Special Projects funding. The representative from the Waste Utilization Subcommittee was absent due to issues surrounding the Walkerton incident. The report was submitted after the meeting to the secretary. In view of the absence of the Tobacco Subcommittee chair, some discussion was held as to whether their interests would be best served by merging with the Field Crops subcommittee. This matter was left to be discussed by the subcommittee chairs. Following reports from OMAFRA and OSCIA, the committee participated in a tour of ECORC and update of current research activities.

The following day, industry reports were received, and members presented station reports pertaining to research activities at the various U of Guelph and AAFC research facilities. Discussion then focussed on how best to handle recommendations and research priorities under the new system. Due to lack of representation and reports from two subcommittees, the prioritization of all the recommendations (new, modified and old) was done at a later date by fax.

New or Modified Recommendations for 2000

The following italicized text highlights the changes in the recommendations for 2000/2001.

Recommendation 1: Quantify the biological, physical and socio-economic effects of manure management, in part by developing an environmental index for N, *and an appropriate environmental model that takes into account the influence of soil macropores on movement of materials through the soil.*

Recommendation 3: Improving NPK fertility management of corn, cereal crops, canola, horticultural crops and tobacco for increased yield, quality and profitability, and reduced environmental impact.

> *3) Corn Nitrogen Requirements: General N recommendations for corn were developed using data from the 1960's and 1970's. There is evidence to suggest that the N requirements have increased and that optimum N rates for genetically modified hybrids (eg. Bt corn) may be different. A full review of the general N recommendations is required.*

Recommendation 5: Identification of sources of surface water contaminants *and to develop and field test techniques to identify sources of contamination.*

Recommendation 7: *Validate standards for developing and implementing a nutrient management plan.*

Recommendation 12: *Assess the methods for preparation and handling of samples for nitrate-N analysis.*

ONTARIO SOIL MANAGEMENT RESEARCH RECOMMENDATIONS

Recommendation 1: **Quantify the biological, physical and socio-economic effects of manure management, in part by developing an environmental index for N, *and an appropriate environmental model that takes into account the influence of soil macropores on movement of materials through the soil.***

Issue: **Manure Management**

BACKGROUND:
Environmental effects of manure may occur on the originating farm, or, more often, away from the farm in downstream watercourses and in the global atmosphere. Research is required to quantify the environmental costs of manure-handling activities to the farmer and to society. Likewise, there is a need to quantify the benefits to society, the costs to the farmer, and the net benefits (or costs) to the farmer and to society of the farmer adopting more environmentally benign manure-handling activities.

Source: Waste Utilization Subcommittee

Recommendation 2: **Development of better manure and biosolid application systems to improve nutrient efficiency and reduce the impacts on environmental quality. Prediction of available N from organic materials added to the soil**

Issue: **Manure Management**
Nutrient Use Efficiency

BACKGROUND:
Concentration of the livestock industry into larger production units creates new challenges in manure handling and application. Current research in Ontario addresses many issues associated with manure application, however, some areas of research require much more work. In particular:

1) Manure/biosolid application in no-tillage systems or to perennial field crops: With increased adoption of no-tillage systems in Ontario, methods and techniques of applying manure/biosolids to land to maximize the benefits and minimize the losses are required. Conservation tillage systems reduce soil loss and improve the quality of water flowing off of a field. However, losing the ability to incorporate manure may result in more manure remaining on the soil surface which may result in higher nitrogen (N) losses, more odours, potential manure/biosolid runoff and bacterial contamination of surface waters. Additional research is needed to better quantify environmental impacts of surface applied manure (surface runoff, tile drain contamination, volatilization), amount of incorporation that occurs

following a rainfall, extent of insect problems (eg. Cutworm) resulting from manure left on the soil surface, and crop yield implications. Research should determine the optimum methods, rates and timing of applying manure/biosolids in reduced tillage systems. This research would benefit farmers trying to incorporate no-tillage practices to save soil and improve soil quality (structure and organic matter) while utilizing manure/biosolids as efficiently as possible.

2) P and K Fertility Levels with Respect to Nutrient Management Plans: Farmers continue to look for opportunities to apply manure/biosolids as a fertilizer source for crop production. Often, many years of over application has raised soil test levels of phosphorus (P) and potassium (K) to what is considered excessive by Ontario Soil Test. There is a need to know what impact of excessive fertility levels, specifically P and K, on agronomic crop production as well as potential environmental consequences. For example, excessive K levels in forages will have an impact on dry cow nutrition, but at what level will high K levels in soil have a detrimental effect on the environment and/or crop yields. The benefit of this research would be to help determine safe manure application rates based on all three nutrients (N, P and K).

3) Nutrient Release from Manures: The availability of nutrients from manure depends on the mineralization after application, as well as the magnitude of losses. These will both vary with the timing of manure application as well as the weather conditions following application. Better tools for the prediction of available nutrients from manure, particularly N, need to be developed. Non-fertilizer sources of N such as manures, cover crops, residues and previous crops all need more research to determine the amount of N being released to the following crop. Appropriate means for predicting the N contributions should also be developed. This is important for all crops, but in tobacco has the added impact on leaf quality.

Source: Field Crop Subcommittee
Soil and Water Quality Subcommittee
Waste Utilization Subcommittee
Tobacco Subcommittee

Recommendation 3: **Improving NPK fertility management of corn, cereal crops, canola, horticultural crops and tobacco for increased yield, quality and profitability, and reduced environmental impact. Develop a nitrate nitrogen test for organic (muck) soils.**

Issue: **Nutrient Use Efficiency**

BACKGROUND:
Soil fertility research on several crops such as corn, canola, tobacco, horticultural crops and winter wheat is required to optimize nutrient inputs and crop productivity. In particular:

1) Fertility Management on Cereals and Canola: To optimize crop production, more research is required concerning the effects of K top-dressed on winter wheat, canola fertility with N, P and K, and the effects of chloride on cereal yields and quality. There are knowledge gaps in each of these areas.

2) Fertilizer N, P and K Recommendations for Horticultural crops: There has been minimal research in the past for calibration of fertilizer recommendations for horticultural crops grown on Ontario soils. In many of these crops a "best guess" has been used for establishing fertilizer rates or the rates are based on growing old open pollinated varieties. Research is needed to establish "best" fertilizer rates as well as timing for many fruit and vegetable crops.

3) Corn Nitrogen Requirements: General N recommendations for corn were developed using data from the 1960's and 70's. There is evidence to suggest that the N requirements have increased and that optimum N rates for genetically modified hybrids (eg. Bt corn) may be different. A full review of the general N recommendations is required.

4) Tobacco: Evaluation of nutrient requirements, specifically N and K, on quality and yield of flue-cured tobacco: Soil test calibration data used to determine the recommended amount of crop nutrients to apply to a tobacco crop was developed decades ago. While valid at the time, these data are based on field trials using varieties and production practices that are now outdated and were developed to produce a style of leaf now considered undesirable. Growers and researchers alike are concerned about the validity of the current soil test and the effects that imprecise data can have on crop yield, leaf quality and environmental sustainability.

5) Research and fields trials are necessary to evaluate and calibrate a nitrate-N test for muck (organic) soils. As well, field demonstrations are needed to evaluate quick test technology for nitrates in both mineral and muck soils. This technology is being used in other parts of the world but has not been well studied in Ontario

Source: Field Crop Subcommittee
Horticultural Crop Subcommittee
Tobacco Subcommittee

Recommendation 4: **Improving the management, productivity and profitability of field crop production by increasing our understanding of temporal and spatial variability of soil properties in agricultural fields.**

Issue: **Soil and Crop Management**
Nutrient Use Efficiency

BACKGROUND:
Field variability of nutrient levels, pH, variable response to fertilizer and yields have created many new challenges to farmers. More research is needed into site specific agriculture that will allow us to predict areas of a field that require higher inputs and areas of a field that require lower inputs. Use of this information may allow us to keep more nutrients in the root zone and may lower cost of production of crops in Ontario. Strategies for optimizing inputs to deal with field variability are needed to optimize production on fields. The variables which affect yield most need to be identified along with cost effective, efficient ways of measuring those variables. With increased use of yield monitors in combines management of soil variability to reduce yield variability is becoming a greater issue.

In an informal study, seasonal fluctuations in soil P, K and pH levels have been observed in Ontario. The magnitude of seasonal fluctuation must be investigated and, if seasonal fluctuation is found, the causes must be studied. It also should be determined if the fluctuations are large enough to affect nutrient recommendations in Ontario and to devise methods of sampling so individual operators can minimize fluctuations in recommendations due to temporal fluctuations in soil test values.

Growers are being bombarded with new technology in the horticulture industry. Research is needed to validate and adapt this new technology which includes such things as remote sensing, GPS mapping and yield monitoring.

Current research in Ontario is concentrating on N and varying N rates across the field. The effects of variable P and K fertilization, planting population, weed control and lime, to name just a few, on yield variability and profitability are currently unknown. Much more needs to be learned.

Source: Field Crop Subcommittee
Horticultural Crop Subcommittee
Soil and Water Quality Subcommittee

Recommendation 5: **Identification of Sources of Surface Water Contaminants** ***and to develop and field test techniques to identify sources of contamination***

Issue: **Manure Management**

BACKGROUND:
Beach closures are the most visible symptom of bacterial contamination of surface waters, however, it is seldom clear whether the bacterial source is livestock manure, septic tanks, sewage bypass in sanitary sewers, or wildlife droppings. Identifying the source of contamination would allow the targeting of scarce resources to those cleanup and prevention programs that will have the most impact.

Along with bacteria, manure can also contain protozoa (eg. *Cryptosporidium*) and EDC's (Endocrine Disrupting Compounds), although manure may not be the only source of these contaminants. Identifying the sources of these contaminants will have similar benefits.

Source: Waste Utilization Subcommittee
Soil and Water Quality Subcommittee

Recommendation 6: **Quantify the emission of greenhouse gases from agricultural activities, particularly in relation to manure management**

Issue: **Manure Management**

BACKGROUND:
Agriculture has the potential to be both a source and a sink for greenhouse gases, but the impact of various agricultural activities on the emission of greenhouse gases is largely unknown. There is a need to better understand the role that agriculture plays in the production of greenhouse gases, and the management techniques that could reduce this production. There is an urgent need for information on the emissions of CO_2, CH_4 and N_2O from manure storage (particularly liquid manure storage with crusts) and application.

Source: Waste Utilization Subcommittee

Recommendation 7: **Validate standards for developing and implementing a nutrient management plan.**

Issue: **Manure Management**

BACKGROUND:
As nutrient management plans move from a recommended to a mandated activity, the importance of effective standards becomes critical. The following items need to be addressed:

- Proper soil testing procedures
- Proper manure testing protocols
- Farm ownership and size
- Use of new technologies

- Regulatory mechanisms
- Certification of consultants or contractors.

Source: Waste Utilization Subcommittee

Recommendation 8: **Nutrient recycling from greenhouse nursery operations**

Issue: **Nutrient Use Efficiency**

BACKGROUND:
The greatest environmental issue of the greenhouse industry is fertilizer leachate. Ongoing research is necessary to determine recycling systems for greenhouse crops that will reduce or eliminate fertilizer effluent from greenhouses.

In the area of flue-cured tobacco seedling production in float trays, determination of methods to utilize nutrient enriched water in an environmentally friendly manner and further investigation on the nutrient requirements for producing high quality seedlings are needed. Other concerns include the effects of various nutrients, including high soluble salts, on seedling germination, growth and hardiness.

Source: Horticultural Crop Subcommittee
Tobacco Subcommittee

Recommendation 9: **Overcoming factors limiting crop production when growing no-till corn and horticultural crops**

Issue: **Soil and Crop Management**

BACKGROUND:
The adoption of no-till or reduced till appears to have leveled off in the past two years. Some of this can be traced to economics (farmers are more risk averse when commodity prices are dropping or production has been affected by weather). Equally significant are the unanswered questions (real or perceived) concerning management of reduced tillage in specific situations. As the size of farming operations increases, the tendency is to use the "lowest common denominator" (the tillage system which works on the widest range of soils) instead of the most appropriate system for a specific field. This can lead to soil degradation and water quality problems.

1) Fine Tuning No-till Systems: Although there has been much work done relating the effects of tillage systems on the production of crops in Ontario there are still unanswered questions. Producing no-till corn on fine textured, wet soils is still a challenge. The effects of planting in wet conditions with no-till and reduced tillage have not been addressed. Research should be continued on improving the no-till system and making it more adaptable to specific problem soils.

2) Managing Wheat Residue: Additional research is required to overcome some of the problems with planting no-till corn after winter wheat. Farmers have identified reduced emergence and plant stands and reduced yields related to growing no-till corn after winter wheat. Research to investigate residue management after winter wheat should continue. Methods of coping with the increased residue on the soil surface and cooler, moister seedbed conditions must be developed.

3) Lime application: Lime issues related to no-till crop production should also be addressed. Lime is relatively insoluble and immobile in the soil. In no-till production when the option of incorporating lime with tillage is no longer available, the efficacy of lime additions is not well documented.

4) Reduced Tillage Systems for Vegetable Production: In the industry there has been little adoption of reduced tillage systems for vegetable production. Research is still needed to identify the level of tillage reduction and the effect of plant residue on vegetable yields and quality for Ontario conditions and soils.

Source: Field Crop Subcommittee

Recommendation 10: **Assess the impact of soil fertility and fertilizer additions on the functional food qualities of crops**

Issue: **Soil and Crop Management**

BACKGROUND:
The growing of crops for their nutraceutical qualities has the potential to be a very lucrative market. Although crops are known to contain different types and levels of nutraceuticals, the impact of management practices on these compounds is not well known. Preliminary results have suggested a positive relationship between soybean isoflavone content and the level of K fertility. Further research is required to determine the influence of fertilizer additions on the functional properties of various food crops (eg. Isoflavones in soybeans).

Source: Field Crop Subcommittee

Recommendation 11: **Improving secondary and micronutrient fertilization of field and horticultural crops**

Issue: **Nutrient Use Efficiency**

BACKGROUND:
There has been an increase in the use of secondary and micronutrients (both foliar and soil applied) in the horticulture industry. Research is needed to evaluate the effectiveness of these nutrients on the yield and especially quality of horticultural crops.

Boron is occasionally deficient for some field crops in Ontario (particularly alfalfa), while other field crops are highly sensitive to boron and yields are reduced by high boron levels. Research is needed to develop an effective soil test which can be used as a predictor for Ontario soils. Research is also needed into the management of boron for crop production, both in deficient and excess soils.

Although canola growers are experimenting with applying micronutrients, there has been little or no research into the micronutrient requirements of canola.

Calibration research should be conducted with respect to the levels of calcium and magnesium in Ontario soils. There is currently a gap in the data used for recommending calcium and magnesium application to Ontario soils.

Tobacco growers are interested in the effects of calcium when applied at transplanting, side-dressing, and/or as a foliar application with sucker control on agronomic performance including the incidence of bruise green.

Source: Field Crop Subcommittee
Horticultural Crop Subcommittee
Tobacco Subcommittee

Recommendation 12: **Assess the methods for preparation and handling of samples for nitrate-N analysis.**

Issue: **Nutrient Use Efficiency**

BACKGROUND:
Soil samples for nitrate-N analysis are normally frozen until analysis, but this precludes grinding and mixing which would normally remove much of the heterogeneity of the sample. A comparison of frozen samples, air-dried and ground samples, and low-temperature oven-dried and ground samples needs to be done to assess which will produce the most reliable results.

Source: Soil Test Subcommittee

Recommendation 13: **Determining the Optimal Type, Width and Management of Buffer Strips to Reduce Soil, Nutrient and Pesticide Loss into Watercourses**

Issue: **Wetlands and Riparian Zone Management**

BACKGROUND:
It is well recognized that various agricultural activities have the potential to cause deleterious effects on water quality and on the aquatic habitat, especially stream habitats. These impacts result from input of nutrients, other chemicals, and sediments. In recent years, however, it has

been shown that the proper management of buffer strips can substantially alleviate some pollution problems caused by agricultural practices. For example, many researchers have observed that a large percentage of nitrate N in subsurface flow moving towards the stream is removed from the water as it passes through the buffer strip. Similar observations have been made with respect to the sediments in the surface runoff.

Based on such facts, the use of buffer strips has been suggested in the Ontario Environmental Farm Plan and in the Best Management Practices for water and soil management. However, in Canada, research on the effectiveness of buffer strips in reducing non-point source pollution is virtually non-existent. Management practices should be developed for Ontario soil and climatic conditions. For example, what is the optimal crop species, width and management regime required to control non-point source pollution to a predetermined limit? How should buffer strip width and type be varied with different soil textures and slope conditions? Additional research should be conducted to address these questions for sustainable crop production and improved environmental quality. Some of these basic questions pertaining to the width and type of vegetation needed to achieve a certain level of non-point source pollution control have never been investigated. There is a need for research pertaining to:

1) the movement of nutrients in surface and subsurface flows through riparian zones.
2) the movement of sediment through riparian zones.
3) The identification of the adequate combination of width and vegetation type in the buffer strip needed to achieve a pre-determined extent of control of non-point source pollution.

Source: Soil and Water Quality Subcommittee

Recommendation 14: **Development and calibration of multi-element extractants suitable for Ontario soils.**

Issue: **Soil and Crop Management**
Nutrient Use Efficiency

BACKGROUND;
The current accredited soils tests in Ontario require four different extractions for a basic soil analysis, as well as the use of wet chemistry to measure the concentration of the nutrients in the extract. This adds costs to the operation of a soil test lab, and ultimately to the farmers of Ontario. Other provinces and states are using the Mehlich 3 extractant for soil analysis, but it is not appropriate for Ontario because of the large areas of alkaline soils. Development of a single multi-nutrient extractant for soil testing would be beneficial to both the soil test labs and the farmers of Ontario. Lab procedures would be simplified, leading to lower costs and fewer errors, there would be less toxic waste material produced, and the tests could cover a number of nutrients not currently tested. These developments would help make site specific crop management and manure management more economical.

This research should look beyond traditional soil sampling and analysis. In Quebec and Saskatchewan, development of exchange resin based soil tests is proceeding. Research on

environmental impacts of P losses is also revealing alternative tests for soil P that may be more effective in predicting crop P requirements.

Source: Soil Test Lab Subcommittee

Recommendation 15: **Crop rotation systems to enhance soil quality and improve crop productivity**

Issue: Soil and Crop Management

BACKGROUND:
The selection of crops within a rotation can play a significant role in the overall productivity and quality of the soil. Recent changes in Ontario have increased the need for research in the following areas:

1) Maximizing Yields Under a Short Term Soybean Rotation: The economic climate in Ontario agriculture makes the growing of soybeans very attractive. Farmers in the province are beginning to grow soybeans in very short rotations (if they use rotations at all). Studies should be run to determine how to best maintain yields of soybeans. How long (or short) should soybean based rotations be to prevent the buildup of pathogens such as rhizoctonia root rot, soybean cyst nematodes, etc.? What is the impact of other rotational crops (such as canola) on soybean yields? Much work was done with corn and many of the problems that were studied for corn must be studied for soybeans as well.

2) Crop Rotation and Sequence Effects on Soil Quality: Many crop rotations and sequences have not been studied. For example, there appears to be reduced yields of many crops grown after canola. Research should be conducted to determine the effects various crop sequences have on overall productivity and sustainability.

3) Cover Crops in Horticultural Systems: Cover crops are still used only rarely in fruit and vegetable production in Ontario. Research is needed to determine the best systems to incorporate cover crops into annual vegetable production systems and to determine the best sequences of crops in these systems. Also, ongoing trials and research are necessary to compare cover crop and organic amendments, and their effects on soil nematode populations.

Source: Field Crop Subcommittee
Horticultural Crops Subcommittee
Soil and Water Quality Subcommittee

Recommendation 16: **Water Table Management for Optimal Crop Production and Environmental Quality**

***Issue:* Soil and Crop Management**

BACKGROUND:
Subirrigation, irrigation, controlled drainage and fertigation all have shown some promise in Ontario. In the past few years, research has been conducted on water table control systems in SW Ontario. Generally the control of water tables consists of lowering the water table to enable planting earlier in the year. Recent results have indicated that controlling water table levels by either raising or lowering the water table, depending on soil moisture conditions, has increased yields of some crops in some years. More research is needed to determine the complete benefits and effects of controlling water tables throughout the growing season in different areas of the province with different climates and crops. More research is needed to determine the economic and environmental sustainability of these crop production practices.

Source: Field Crop Subcommittee
Soil and Water Quality Subcommittee

***Recommendation 17:* Management of Organic Matter Amendments on Horticulture Crops, Flue-Cured Tobacco Production Systems**

***Issue:* Soil and Crop Management**

BACKGROUND:
There is ongoing interest in using various organic amendments as part of a crop production system, both by farmers and by the producers of the amendments. There are potential benefits to using these materials, both as a fertilizer and as a way to increase soil organic matter content. There are, however, potential problems with heavy metals, salts or N tie-up.

Continuing research is necessary to determine the effectiveness and adaptability of these amendments to horticultural production.

Methods must also be developed to evaluate metals and other contaminants in sewage biosolids, paper waste, and manure, including how organic matter affects the transport of contaminants and their uptake by plants.

Source: Horticultural Crop Subcommittee
Waste Utilization Subcommittee

Recommendation 18: Determining Key Soil Quality Characteristics for the Development of Improved Soil Management Systems

Issue: **Soil and Crop Management**

BACKGROUND:
Soil quality is a vague and relative term that must be defined and soil chemical, physical and biological attributes must be developed. Soils provide many functions, and when one or more factors are constrained then crop productivity and environmental quality are compromised. A list of key parameters must be established and optimal ranges of measurements defined. For example, physical properties may consist of water transmission rates, storage and aeration status; chemical properties may include total and labile organic matter, etc. Long-term studies could be used to develop and test these biological, chemical and physical indicators and these could then be applied to short term studies to evaluate their potential as a sustainable management tool.

Soil quality should be one of the components of any research into crop management, manure management or tillage systems, so this research can be better extended to other areas and cropping systems.

Source: Soil and Water Quality Subcommittee

Recommendation 19: **To investigate the effectiveness of urease inhibitors as a means of increasing fertilizer use efficiency and crop productivity**

Issue: **Nutrient Use Efficiency**

BACKGROUND:
Ideally none of the inputs used in agriculture should leave the root zone of a field. This, however, is not always the case. Research should be conducted into improving fertilizer efficiency so that nutrients are maintained in the root zone while crop yields are optimized. This includes improving the ability of detecting plant available N from organic sources using soil testing. Extensive research in the US and Canada has shown significant reductions in ammonia losses from urea using urease inhibitors. Use of these products could assist greatly in matching application rates of urea to crop demand, and reducing losses of N in the form of nitrate as well as ammonia. Further research to support the use of urease inhibitors in Ontario would assist the adoption of such products for use in Canada.

Source: Field Crop Subcommittee

2000 Ontario Soil Management Research and Services Committee
Annual Meeting
Minutes

The annual meeting of the Ontario Soil Management Research and Services Committee was held on June 6 and 7 at ECORC, AAFC, Ottawa.

Attendance:

Ivan O'Halloran
Craig Drury
John Rowsell
Peter Haulena
Christoph Kessel
Ron Beyaert
Brent Kennedy
Adam Hayes
Paul Voroney
Anne Verhallen
Bill Curnoe
Maria Derkacz
Sid Ryzebol
Ed Gregorich
Doug Young
Paul Brine, ERLD
Keith Reid

Regrets: Pat Feryn, Tom Bruulsema, Susan Fitzgerald

Adoption of 1999 Annual Meeting Minutes: (Hayes, Young) Carried.

Sub-Committee Reports:
Field Crops - Doug Young
Report attached.

Suggested changes to Publication 296:
Pg. 21, Table 2-5: Change "Mn deficiency has not been diagnosed in Ontario" to "Mn deficiency is uncommon in Ontario."

Pg. 22: Change wording of first sentence to "B deficiency is only rarely observed in cereals."

Pg. 131, Table 10-3: "Based on OMAFRA accredited soil tests" should be dropped, as there is no accredited N test for several of the listed crops.

Add "and/or Certified Crop Advisor (CCA)" when referring readers to contact their OMAFRA office for technical expertise.

Motion to accept report: (Curnoe, Drury) Carried.

Hort Crop Subcommittee – Christoph Kessel
Attached.

Recommendation Changes:
1.Ex tend nitrogen recommendation chart for apples to include higher planting densities, and higher rates for older trees.

Moved to send back to Hort Crop Subcommittee for further documentation/justification. (Young, Voroney) Carried.

2. Add Soi l applied boron as an option for correction B deficiency in apples, as determined by foliar analysis (remove reference to soil test B level). Motion to accept recommendation (Kessel, Curnoe) Carried.

Motion to accept report: (Kessel, Curnoe) Carried.

Soil & Water Quality Subcommittee – Adam Hayes (for Pat Feryn)
Report attached. Note that the comment regarding the soil N test recommendations for corn in Publication 296 was due to a misunderstanding about the sampling depth being assumed for the test.

A nitrogen index should be developed to deal with the risk of nitrate leaching into groundwater. This is currently being worked on by LRS and OMAFRA under OASCC Special Projects funding.

Motion to accept report: (Hayes, Kennedy) Carried.

Soil Test Lab Subcommittee – Peter Haulena
Report attached.

Motion to accept report: (Young, Rowsell) Carried.

Waste Utilization Subcommittee – deferred in the absence of a representative. Brent Kennedy will try to get a report faxed to the meeting.

Tobacco Subcommittee - deferred in the absence of the chair. Ron Beyaert will get a copy of the report and forward it to the secretary for attachment.

There was a brief discussion of whether the interests of the Tobacco subcommittee would be better served by merging with the Field Crops subcommittee. This will be a matter for discussion by the subcommittee chairs.

Concern was raise about the potential overlap between the Field Crops Committee and OSMRSC, with the potential for much duplication of effort as well as missed priorities. There was also concern regarding the fate of any production recommendations from OSMRSC when they reached OASCC and the University of Guelph research program. Motion to have the chair of OSMRSC send a letter to Gary Ablett (Chair of FCRC) and Bruce Bowman (Chair of OSWARSC) encouraging communication between the committees, and the U of G Research Program, to resolve this issue. (Rowsell, Curnoe) Carried.

OMAFRA Crop Technology – Brent Kennedy
Major re-organization this past winter – organizational chart attached to minutes. Focus of specialist is moving towards working with information multipliers – agribusiness, media, internet.

OSCIA – Sid Ryzebol

- The organization has developed a business plan
- Grant programs have been revised, to provide funding for regional projects as well as county projects
- The operations of OSCIA have been restructured to deal with less OMAFRA assistance.
- OSCIA provided input on the consultations on large livestock farms, and on the drainage act review.

Tour of ECORC and update on current research:

Ian Jarvis: (Pedologist) working on a regional Land Resource Study. Eventual goal is to have seamless land resource information for the entire country. Current maps can be found at:

http://res.agr.ca/CANSIS/NSDB/DETAILED/ON/

(note that the address is case-sensitive)

Elizabeth Paddy: (Micrometeorologist) Measuring the radiance signature of a leaf or plant with a spectroradiometer, relative to a white standard. Scaling up presents many challenges as well as rewards. Technique is being assessed at the scale of the leaf, the plant, and the field.

Sherman Nelson: (Section Head) working on the response of increasing mycorhizal infection on corn yields. He has been producing an inoculum by mixing field soil with perlite (50/50 mix), and introducing mycorhizae on leek roots. After this is allowed to grow for a season, the soil is dried and ground. This inoculant contains 2-500 times the amount of mycorhiza as normal soil. Inoculant is applied to corn at planting, at a rate of 30 ml/seed. Significant corn yield increases were achieved with inoculant applied to corn receiving 100N, 200N or composted manure. No sgnificant difference in corn with no additional N, or un-composted manure.

Ed Gregorich: using Time Domain Reflectrometry (TDR) to measure bulk soil electrical conductivity (related to solute concentration) as well as soil moisture. This may allow the use of TDR to quickly estimate nitrate concentrations in the soil, where nitrate is the dominant anion.

Neil McLaughlin: continues to work with instrumented tractor. Addition of GPS has allowed production of maps of fuel use, torque, etc.

Clarke Topp: has developed an instrument that will automatically measure soil resistance to penetration as well as soil moisture ("Terra-Point").

David Lapen: (working jointly with AAFC and U of G – Kemptville) – deriving relationships between draft, volumetric moisture, penetrometer reading, and yield.

Baolo Ma: Trying to use reflectance at specific wavelength ("Cropscan") to predict sidedress N requirements in corn.

We also went to look at the equipment in the field.

Industry Reports:
Reports received from OABA and PPI (attached).

Station Reports:
RCAT - Doug Young
Report Attached

KCAT – Bill Curnoe
Three main project areas:

1. B iosolid Application (4 different paper wastes, rice hulls, and milk processing waste) – soil parameters, crop yields
2. Tillag e X Rotation study
3. Project with AAF C on Best vs. Worst management, and cash crop vs. livestock rotations

Slow start to spring due to wet conditions, but plots are all planted now.

New Liskeard (John Rowsell) – a limited amount on canola N work going on, in co-operation with Dave Hume and Keith Reid

HRIO – Maria Derkacz
Report Attached.

Land Resource Science – Paul Voroney
Paul reported briefly on changes within the department:

- Two positions have been hired but not officially announced, one in soil fertility and one in pedology to replace Dick Protz.
- Bev Kay and Eric Beauchamp– predicting release of organic N
- Paul Voroney – Soil Carbon dynamics
- Michael Goss – manure management, mycorhizal infection on soys
- LRS is now putting annual reports on the web – '97 and '98 are there now, '99 should be posted soon http://www.uoguelph.ca/~gparkin/lrs/annreport.htm
- A complete list of LRS projects are available on the OMAFRA website (http://www.gov.on.ca/OMAFRA/english/research/ario/index.html)

AAFC Delhi/London – Ron Beyaert
London – soil organisms/populations
Delhi – Cropping systems, rotations, nematode suppression with cover crops
Manure injection, N leaching, rye intercrop in corn
Lazarovitz – biological disease control
Beyaert – Ginseng fertility,
Impact of GMO's on soil flora/fauna
Irrigation / Sub-irrigation management

ECORC – Ed Gregorich
Model!ing Group - assessing impact of climate change on agriculture
Modeling CHU accumulation from remote sensing

CANSIS - Goal: "seamless" soils information across Canada
Maintaining sols database

Agronomy - Clarke Topp: O_2 profile with best and worst management
Ed Gregorich: C sequestration in no-till, impact of tillage
Elizabeth Patty: GHG fluxes from different cropping systems
Plus all the research described in the tour.

AAFC Harrow (GPCRC) – Craig Drury
Report attached.
Note that Cathy Fox has been transferred to Harrow

Research Recommendations could not be completed because recommendations had not arrived from two committees.

There was a discussion of how to handle recommendations:

- Issue based vs. priorizing individual recommendations (some merit to each approach)
- Reactions to recommendations should be sent back to sub-committeess
- OSMRSC meeting can be tailored year to year, depending on where in the cycle of the U of G programs we are. All issues and recommendations need to be thoroughly reviewed in year prior to next funding cycle (2002). In "between" years, focus should be in identifying new/revised recommendations, and reviewing progress towards achieving priorities
- In years when OASCC recommendations are not being totally revised, a "mini-workshop" on a particular issue could be considered.
- Note that new recommendations cannot be ignored in the "non-OASCC" years, because other bodies use the recommendations to set their funding priorities (eg. AAFC, AAC, etc.)

Motion that the executive of OSMRSC be charged with developing a "modus operendi" for the operation of the committee, and circulate to the group for comment by the end of September (Rowsell, Hayes). Carried. (Note: this should include expectations from subcommittees and station reports, templates, priority activities for different years in the cycle, role of BPJ of committee in commenting on issues of the day)

Service Recommendations:

1.Composting factsheet (Hort Subcommittee)
A factsheet or factsheets on composting should be prepared (current research, how to do it, summary of regulations, waste amendments).

2.Precision A griculture (Soil & Water Quality Subcommittee)
Efforts must be increased to get the information that we know NOW out to the public quickly, as well as continuing research. Overlap between industry and research activities must be addressed. The demonstration focus should be increased, and research must be scaled up to the farm level. There must be three-party co-operation: the grower, OMAFRA, and industry.

3.Nutrien t Management (Soil & Water Quality Subcommittee)
Research information on manure management needs to be distributed quickly.

Growers need information on how to apply manure without losing nutrients to the water or air, how to apply a uniform spread pattern in a low-tech manner, and management options for minimizing manure flow to tiles and utilizing manure in no-till.

4.Soil Manag ement (Soil & Water Quality Subcommittee)
Increasing the acreage of no-till or ridge-till crops, especially corn, needs to be addressed.

Election of Officers:

Chair: nomination - Ron Beyaert (Young, Rowsell)
Motion to close nominations (Voroney, Hayes) Carried.
Acclaimed.

Vice-Chair: nomination – Adam Hayes (O'Halloran, Beyaert)
Motion to close nominations (Voroney, Beyaert) Carried.
Acclaimed.

Secretary: consensus of the meeting was that Keith Reid should continue as secretary.

Next Meeting: June 12-13, 2001. Tentative location: London area. (May only need one day, depending on the format of the meeting.)

Provincial Soil: The Canadian Society of Soil Science has requested that OSMRSC consider naming a provincial soil. Motion: That OSMRSC strike an ad hoc committee to propose a provincial soil (Drury, Young). Carried.

Suggested members: Craig Drury (chair)
Ian Jarvis
Doug Aspinal
Richard Protz

Motion of adjournment at 10:35 am (Young). Carried.

Ontario Water Management Research & Services Committee
Annual Meeting: Oct 10, 2000.

Present:
Paul Sibley: Environmental Biology, University of Guelph.
Jon Gingerich, Cold Spring Farms.
Chin Tan, Agriculture and Agri-Food Canada
Dan Reynolds, Agriculture and Agri-Food Canada
Ramesh Rudra, Engineering, University of Guelph.
Paul Brine OMAFRA
Keith Reid OMAFRA
Heather Gingerich, University of Western Ontario
Tiny van Pinxteren, Cuddy Farms.
Gary Parkin, Land Resource Science, University of Guelph.

Regrets:
*Mary Jane Conboy, Ontario Federation of Agriculture
*Elbert van Donkersgoed, Christian Farmers Federation
Jim Myslik, OMAFRA.
Allan Crowe, Canada Centre for Inland Waters
Wes Lane, Dairy Farmers of Ontario
*Mike McMorris, Ontario Cattlemen's Assoc
Carl Schlegel \ S. Bradshaw , Ontario Pork
*Yarlene Macabuag, Ontario Clean Water Agency
Michael Goss, University of Guelph\OMAFRA.

People were also invited from:
Essex Region Conservation Authority (*Mathew Child)
Upper Thames River Conservation Authority
Grand River Conservation Authority
University of Waterloo
Ontario Fruit and Vegetable Growers Assoc.

* not present at meeting but submitted comments on the first draft of the Report.

Meeting Agenda:
1.Introductions, 2. Review of 1999 Report, 3. Current Issues\Outline of Report
4. Workshop and New Business

Current Water Management Issues and Recommendations

The emerging water management research and service issues are given below in order of importance. **Research Issues** are presented first with recommendations given in point form after each issue.

1. Manure Management:

- identification of transport pathways of bacteria and other pathogens to groundwater.
-investigate alternatives to liquid manure such as use of organic bedding material and composting.
- pilot-scale testing of new methods of managing\utilizing liquid manure such as composting, condensing, pre-treatments, energy from manure (eg. methane digestion)
- testing of BMPs for liquid manure application timing and methods.
-evaluate the effectiveness of new controlled rate application technologies (flow meters with injection booms) vs. current methods.
- scale of farming operation versus amount of leaching and runoff losses of pathogens and nutrients.
- leaching losses of feed supplements such as growth hormones, antibiotics, micro-nutrients.

2. Management of Non-Manure Fertilizers and Pesticides

- identification of transport pathways of NPK fertilizers and pesticides.
- validation and testing of BMPs for nutrient and pesticide management.

3. Water Source, Transport, and Sharing

- should surface water or groundwater be main sources of potable water?
- urban\rural groundwater sharing, well head protection strategies.
-irrigation management for water conservation and reduction of leaching losses of fertilizer and pesticide.
-rural development strategies to limit the number of new water wells and promote the use of innovative septic systems.

4. Farm Water Cycle

- quantify water pathways including runoff, tile drainage, and deep drainage.
- design of buffer strips and wetlands to enhance protection of surface and ground waters including a cost\benefit analysis.

Scaling is an issue that was put forth as being fundamentally important to all four of the issues given above. For example, there is a need to understand how to properly scale-up parameters measured at a small scale for use in watershed (or even larger scale) models of water and contaminant transport.

The following were classed as **Service Issues** by the committee.

5. Database for water management.

- design and maintain a web-based database for hydrological information and data required to run computer models of water flow and contaminant transport in Ontario.

6. Database for current and past groundwater and surface water quality and quantity.

- design and maintain a web-based database that would have information on current and past groundwater and surface water quality and quantity in Ontario.
-baseline monitoring of groundwater and surface water quality and quantity in Ontario with data available on the web site described above.

The two service issues (Issues 5 and 6) may be currently addressed by the Water Resources Information Program (WRIP). The WRIP is a strategic review of water information programs being completed by the provincial cluster ministries and Conservation Ontario. We hope to have a representative from Conservation Ontario to discuss WRIP at the Workshop discussed below.

The current water management research and service issues described above can be divided into water quality (Issues # 1 and 2) and water quantity (Issues # 3 and 4). Issues # 5 and 6 include aspects of both water quality and quantity. The research issues and recommendations are very similar to those presented to OSWARSC last year.

Workshop on Emerging Issues in Water and Agriculture in Ontario

It was agreed that a workshop on emerging issues in water management and agriculture in Ontario should be held at OMAFRA Building, 1 Stone Rd., Guelph during the week of Feb. 19-23, 2001. The one-day workshop will include oral and poster sessions on issues of water quality and quantity related to agriculture in Ontario. Poster presentations on research results from the OMAFRA\University of Guelph Resource Management and Environment Program will be encouraged. Workshops will facilitate small group discussions between people from agriculture industry and organizations, universities, government research and extension. Paul Sibley and Gary Parkin agreed to co-chair the workshop.

APPENDIX II
OSWARSC Committee Membership

Ontario Soil Water and Air Research and Services Committee

Ontario Agrometeorology Research and Services Committee

Ontario Soil Management Research and Services Committee
- Field Crops Committee
- Horticultural Crops Committee
- Soil and Water Quality Committee
- Soil Test Lab Committee
- Tobacco Committee
- Waste Utilization Committee

Ontario Water Management Research and Services Committee

Committee Memberships

Ontario Soil, Water and Air Research and Services Committee:

Bruce Bowman Agriculture & Agri-Food Canada 1391 Sandford St. London, ON N5V 4T3 Tel: 5194571470 x.239 Fax: 5194573997 Email: bowmanb@em.agr.ca	Keith Reid OMAFRA 581 Huron Street Stratford, ON N5A 5T8 Tel: 5192719269 Fax: 5192735278 Email: keith.reid@omafa.gov.on.ca
Ian Jarvis AAFC - ECORC Ottawa, ON K2A 0C6 Tel: 6137591477 Fax: 6137591924 Email: jarvis@em.agr.ca	Sherman Nelson AAFC – ECORC KW Neatby Ottawa, ON K2A 0C6 Tel: 6137591901 Fax: 6137591926 Email: nelsonsd@em.agr.ca
Craig Drury AAFC - GPCRC County Rd. 20 Harrow, ON N0R 1E0 Tel: 5197382251 x.473 Fax: 5197382929 Email: druryc@em.agr.ca	Michael Payne OMAFRA 581 Huron St. Stratford, ON N5A 5T8 Tel: 5192714496 Fax: 5192735278 Email: michael.payne@omafra.gov.on.ca
Kevin McKague OMAFRA 1 Stone Rd. W. Guelph, ON N1G 4Y2 Tel: 5198263557 Fax: Email: kevin.mckague@omafra.gov.on.ca	Doug Aspinall OMAFRA 1 Stone Rd. W. Guelph, ON N1G 4Y2 Tel: 5198263575 Fax: Email: doug.aspinall@omafra.gov.on.ca
Michael Goss University of Guelph Guelph, ON N1G 7W1 Tel: 5198244120 x.2491 Fax: 5198263801 Email: mgoss@research.uoguelph.ca	Ivan O'Halloran Ridgetown College, University of Guelph Ridgetown, ON N0P 2C0 Tel: 5196741635 Fax: 5196741600 Email: iohallo@ridgetownc.uoguelph.ca
Alvin Topp O.S.C.I.A. Tel: 9057748380 Fax: 9057748380 Email:	Maria Derkacz University of Guelph Vineland, ON Tel: Fax: Email: mderkacz@uoguelph.ca
Don McCabe Ontario Corn Producers Association Tel: 5198442482 Fax: 5198442603	Bill Curnoe Kemptville College Kemptville, ON Tel: 6132588336 x.333

Email: dmccabe@xcelco.on.ca	Fax: 6132588477 Email: bcurnoe@kemptvillec.uoguelph.ca
John Rowsell New Liskeard Agricultural Research Stn. New Liskeard, ON Tel: 7056478525 x.221 Fax: 7056477008 Email: jrowsell@onlink.net	Claire Sherk O.F.C.R.C. Tel: 5198394208 Fax: Email: csherk@wincom.net
Ginty Jocius A.R.I.O. Tel: 5198222880 Fax: Email: jocius@ginty.jocius.com	Ted Briggs U.T.R.C.A. Tel: 5194512800 x.247 Fax: Email: briggst@thamesriver.org
Gilbert Vansteelandt Ag Care R.R. # 2 Dublin, ON N0K 1E0 Tel: 5195220648 Fax: 5195221010 Email:	Paul Brine OMAFRA Research Branch 1 Stone Rd. Guelph, ON N1G 4Y2 Tel: 5198264162 Fax: Email: paul.brine@omafra.gov.on.ca
Dave Hume University of Guelph Tel: 5198263800 Fax: 5198263841 Email: dhume@research.uoguelph.ca	Ed Topp AAFC London, ON Tel: 5194571470 x.235 Fax: 5194573997 Email: toppe@em.agr.ca
Mary Jane Conboy OFA Tel: Fax: Email:	

Ontario Agrometeorology Research and Services Committee:

Dr. Alan McKeown (Chair) University of Guelph Dept. Plant Agriculture Box 587 Simcoe, Ontario N3Y 4N5 519-426-7127 ext 329 519-426-1225 fax amckeown@uoguelph.ca	Steve Eastep R.R.#1 Elora, Ontario N0B 1S0
Dr. Terry Gillespie Land Resource Science University of Guelph Guelph, Ontario N1G 2W1 519-824-4120 ext 2447 tgillesp@lrs.uoguelph.ca	Dr. Jon Warland Land Resource Science University of Guelph Guelph, Ontario N1G 2W1 519-824-4120 ext 6374 jwarland@lrs.uoguelph.ca
Randy S. Mawson Client Services Representative Environment Canada-Ont. Region 7 South St. East Aylmer West, Ontario N5H 1P5 519-823-4208 519-826-2083 fax randy.mawson@ec.gc.ca	Chris Marshall Environment Canada, Client Services 4905 Dufferin St., Downsview, Ont., M3H 5T4 416-739-4578 416-739-4603 fax Chris.marshall@ec.gc.ca
Dr. Murray Brown 195 Glenforest Road Cambridge, Ontario N3C 1V6	Dr. Tom Jewett Agriculture & Agri-Food Canada 2585 County Rd. 20, Harrow, Ontario N0R 1G0 519-738-2251 ext 422 jewettt@em.agr.ca
Dr. Henry Hayhoe Centre for Land & Biol. Res. Agriculture & Agri-Food Canada Ottawa, Ontario K1A 0C6 hayhoeh@em.agr.ca	Lynn Girty R.R.#3 Blenheim, Ontario N0P 1A0
Dr. Ron Pitblado Ridgetown College of Agricultural Technology University of Guelph Ridgetown, Ontario N0P 2C0 519-674-1605 rpitblad@ridgetownc.uoguelph.ca	Ian Nichols Ridgetown College of Agricultural Technology University of Guelph Ridgetown, Ontario N0P 2C0 519-674-1532 inichols@ridgetowc.uoguelph.ca

Heather Griffiths OMAFRA, Agronomy Building Ridgetown College Box 400 Ridgetown NOP 2C0 519-674-1694 Heather.Griffiths@omafra.gov.on.ca	Diane Harvey Ontario Grape Growers Marketing Board, P. O. Box 100 Vineland Station, Ontario, L0R 2EO 905-688-0990 dharveyOGGMB@juno.com
Len Davies, Manager Western Region Crop Insurance Ridgetown, Ontario N0P 2C0	Mr. Robert Boggs World Weather Watch 401 Bentley Crescent, Unit #4 Markham, Ontario L3R 9TR

Ontario Soil Management Research and Services Committee:

Dr. Craig Drury (Past Chair)
Agriculture & Agri-Food Canada
Greenhouse & Processing Crops Research Centre
2585 Cty Rd. 20
Harrow, ON N0R 1G0
Tel: 519-738-2251 ext. 473
Fax: 519-738-2929
E-mail: druryc@em.agr.ca

Dr. Ivan O'Halloran (Chair)
Ridgetown College of Ag. Technology
Ridgetown, ON N0P 2C0
Tel: 519-674-1635
Fax: 519-674-1600
E-mail: IOHallo@ridgetownc.uoguelph.ca

Mr. Keith Reid (Secretary)
Soil Fertility Specialist, OMAFRA
220 Trillium Court, RR#3,
Walkerton, ON N0G 2V0
Tel: 519-881-3301
Fax: 519-881-2739
E-mail: kreid@omafra.gov.on.ca

Mr. P.A. Blais
Alfred College of Ag. Technology
Alfred, ON K0B 1A0
Tel: 613-679-2218
Fax: 613-679-2415
E-mail: pblais@alfredc.uoguelph.ca

Mr. John Rowsell
New Liskeard Agric. Res. Station
Box G
New Liskeard, ON P0J 1P0
Tel: 705-647-6701
Fax: 705-647-7008
E-mail: jrowsell@onlink.net

Dr. E. Gregorich
Agriculture & Agri-Food Canada
Central Exp. Farm
Ottawa, ON K1A 0C6
Tel: 613-759-1909
Fax: 613-759-1926
E-mail: gregoriche@em.agr.ca

Dr. R. Beyaert (Vice-Chair)
Agriculture & Agri-Food Canada
Research Centre
Delhi, ON N4B 2W9
Tel: 519-582-1950
Fax: 519-582-4223
E-mail: beyaertR@em.agr.ca

Mr. Marcel Anseeuw (Chair, Tobacco Subcommittee)
R.R.#1,
Walsingham, ON N0E 1X0
Tel: 519-586-2327
Fax: 519-586-2385
E-mail: mjanseeuw@webtv.net

Ms. Maria Derkacz
Horticultural Experiment Station
Box 7000
Vineland Station, ON L0R 2E0
Tel: 905-562-4141 ext. 137
Fax: 905-562-3413
E-mail: Mderkacz@hrio.uoguelph.ca

Mr. T. Sawyer (Chair Soil and Water Quality Subcommittee)
The Fertilizer Int. of Ontario
Suite 104, 160 Research Lane
Guelph, ON N1G 5B2
Tel: 519-822-7474
Fax: 519-822-3386
E-mail: tfio@sympatico.ca

Mr. W.E. Curnoe
Kemptville College of Ag. Technology
Kemptville, ON K0G 1J0
Tel: 613-258-8334
Fax: 613-258-8477
E-mail: bcurnoe@kemptvillec.uoguelph.ca

Mr. R. Stone
OMAFRA
Box 8200, 95 Dundas St.
Brighton, ON K0K 1H0
Tel: 613-475-1630
Fax: 613-475-3835
E-mail: bstone@omafra.gov.on.ca

Ms. Maribeth Fitts (Chair Horticulture Crops Soil Management Subcommittee)
Ont. Ministry of Agriculture, Food & Rural Affairs Box 8000
Vineland Station, ON L0R 2B0
Tel: 905-562-4147
Fax: 905-562-5933
E-mail: mfitts@omafra.gov.on.ca

Ms. Anne Verhallen
Crop Tech. Hort.
OMAFRA, Box 400
Ridgetown, ON N0P 2C0
Tel: 519-674-1614
Fax: 519-674-1600
E-mail: averhall@omafra.gov.on.ca

Mr. Adam Hayes
Crop Technology, OMAFRA
Ridgetown College of Ag. Technology
Ridgetown, ON N0P 2C0
Tel: 519-674-1621
Fax: 519-674-1600
E-mail: adhayes@omafra.gov.on.ca

Dr. Tom Bruulsema
Potash & Phosphate Inst. Of Canada
18 Maplewood Dr.
Guelph, ON N1G 1L8
Tel: 519-821-5519
Fax: 519-821-6302
E-mail: bruulsem@ppi-far.com

Mr. Doug Young (Chair Field Crops Subcommittee)
Ridgetown College of Ag. Technology
Ridgetown, ON N0P 2C0
Tel: 519-674-1631
Fax: 519-674-1600
E-mail: dyoung@ridgetownc.uoguelph.ca

Mr. Brent Kennedy Crop Technology, OMAFRA 1 Stone Road West Guelph, ON N1H 6N1	Tel: 519-826-3257 Fax: 519-826-3567 E-mail: bkennedy@omafra.gov.on.ca
Mr. Sid Ryzebol Ont. Soil & Crop Imp. Association R.R. #7 Orangeville, ON L9W 2Z3	Tel: 519-941-2914 Fax: 519-941-5592 E-mail:
Mr. Eric Bowman Ont. Soil & Crop Imp. Association 1721 Reg. Rd. 3 Enniskillen, ON L0B 1J0	Tel: 905-263-8245 Fax: E-mail: ebowman@idirect.com
Mr. Peter Haulena (Chair Ontario Soils Lab Subcommittee) Accutest Labs, 146 Colonnade Road, Unit #8, Nepean, ON K2E 7Y1	Tel: 613-727-5692 Fax: 613-727-5222 E-mail: phaulena@accutestlabs.com
Ms. Christine Brown (Chair Waste Utilization Subcommittee) OMAFRA, Woodstock, ON	Tel: 519-537-6621 Fax: 519-537-5351 E-mail: cbrown@omafra.gov.on.ca

Ontario Water Management Research and Services Committee:

Gary Parkin (Chair), Land Resource Science University of Guelph.	Paul Sibley Environmental Biology University of Guelph
Jon Gingerich Cold Spring Farms	Chin Tan Agriculture and Agri-Food Canada
Dan Reynolds Agriculture and Agri-Food Canada	Ramesh Rudra Engineering University of Guelph
Paul Brine OMAFRA	Keith Reid OMAFRA
Heather Gingerich University of Western Ontario	Tiny van Pinxteren Cuddy Farms
Mary Jane Conboy Ontario Federation of Agriculture	Elbert van Donkersgoed Christian Farmers Federation
Jim Myslik OMAFRA	Allan Crowe Canada Centre for Inland Waters
Wes Lane Dairy Farmers of Ontario	Mike McMorris Ontario Cattlemen's Assoc
Carl Schlegel \ S. Bradshaw Ontario Pork	Yarlene Macabuag Ontario Clean Water Agency
Michael Goss University of Guelph\OMAFRA	

APPENDIX III

Responses to 1999 Recommendations

Infrastructure Issues

ARIO Response to Infrastructure Issues

We recognize the continued importance of resolving these infrastructure issues so that more effective use can be made of the available research resources.

There has been significant progress made towards addressing the concerns about data collection and management and we continue to encourage the stakeholders to continue to work to make further progress.

It should be noted that the collection, maintenance and distribution of soil, water and weather are not research issues but are service and as such should be directed to the appropriate agencies for response.

The effect of scale is a key element of all research. Projects funded by OMAFRA, through the research programs at the University of Guelph, are expected to outline technology transfer milestones which will take research results from the plot or laboratory bench to the end user. Researchers, as part of their routine research activities should be seeking to verify that results at the plot scale are applicable to the real world situation.

The Resources Management and Environment Program at the University of Guelph has identified scaling as a major goal in each of the six resource areas. Research projects on scaling can be supported through the open issue.

We note the continued request for an academic chair to study the scaling and encourage the agri-food industry to discuss ways of developing the substantial financial support needed to implement such a chair.

Research Issues

ARIO response to OSWARSC research recommendations

In April 1999, the University of Guelph presented the new Resources Management and Environment to ARIO. This issue based research program will cover from 1999-2003.and allows for research into the biophysical, economic and social implications of resource management issues confronting the agri-food sector in Ontario. Research will focus on the management of biophysical and socio-economic resources to ensure a competitive agri-food sector while enhancing and preserving the environment.

In order to address the long term program objectives and goals a set of research issues were identified which will contribute to the long term requirements. The issues listed are in response to the needs for urgent information put forward by the OASCC committees. Research conducted on these issues will be expected to contribute to the overall objectives and goals of the program. Each issue has short term (4 years) desired outcomes listed.

The program as approved by ARIO addresses all of the existing research recommendations brought forward by OSWARC from the previous year. A list of projects funded under the program in the first year is included. We would encourage you to incorporate these projects into the research inventory if they are not already included.

Details of the program and projects can be obtained from the program director, Dr. Michael Goss.

The committee is to be commended for the compilation of a research inventory. Having this available will greatly assist in identifying gaps in existing research.

It was noted that the committee is putting forward a number of new recommendations regarding research needs. The limited financial and human resources available dictate that not all priorities can be addressed simultaneously. In order for new priorities to be addressed, or emphasis shifted, existing research must be scaled back or completed so that the resources can be reallocated. Committees can assist in this process by identifying research areas which are no longer high priority so that resources can be redirected.

Currently, a number of the research areas identified in the new recommendations are currently being addressed. The call for proposals for this year's Special Research Program has identified development of a nitrogen index as one of the research areas. Proposals are currently being evaluated.

The area of nutrient recycling for greenhouse and nursery operations is currently being addressed in the horticulture section of the plants program.

Greenhouse gases are recognized as an important issue for the future and have been identified as one of the issues in the Resource Management and Environment program. Currently three projects are underway in this issue (see attached project inventory). In order to expand research in the area of greenhouse gases current research in this or other areas must be either scaled back or completed to make the resources available. OASCC committees can assist in this process by identifying research areas which are no longer high priority.

Resource Management and Environment Program
Research Projects 1999-2000

Agri-food support policy

- Managing agricultural risks. C. Turvey
- Management options and the role of support policies in minimizing climate related risks and promoting efficiency in Ontario food production. B. Smit

Agri-food research policy

- Assessment of agricultural research benefits, commodity strategies and policy issues. G. Brinkman

Changes to trade agreements

- International agri-food trade and its domestic impacts. K. Meilke

Environmental management systems

- Economic assessment of environmental policy instruments for agricultural production. A. Weersink
- Completing the first phase of Farming Systems research. C. Swanton
- Agriculture and wildlife interactions. K. Rollins

Evaluating best management practices

- Quantifying the detrimental effects of improperly timed cultivation under no-till and conventional till practices. B. Curnoe
- Evaluation of alternate policy approaches to support adoption of Best Management Practices. S. Hilts
- Evaluation of best management practices for increasing nitrogen use efficiency on farms. M Goss.
- Developing a framework to assess incentive compatibility of BMPs. K. Rollins

Greenhouse gases

- Evaluation of environmental impacts of manure management treatment technologies. R. Fleming
- Greenhouse gas emissions, removal of air pollutants and nitrate leaching in management systems designed for carbon sequestration. C. Wagner Riddle
- Economic assessment of mitigation scenarios for greenhouse gases in agriculture. A. Weersink

Manure management

- Optimizing methods of applying animal wastes and bio-solids on the land at desired rates. B. Hawkins
- Quantifying water quality impacts of livestock farms and other rural land uses. R. Fleming
- Impact of manure and fertilizer phosphorus applications on phosphorus availability. I. O'Hallorn
- Development of a single integrated computer program for the management of manure, biosolids and mineral nutrients. M. Goss
- Risk assessment and economic evaluation of environmental damage associated with livestock manure – Dietary strategies and handling alternatives. C. Wagner Riddle

Nitrogen Use Efficiency

- Prediction of available N from soil organic matter and residual legume crop. B. Kay
- Baseline nitrate leaching. P. Groenevelt

Product/market development

- Estimating the value of pearl millet using a nutrient component value approach vis-à-vis competing feed grains and forage. J. Fisher
- Economic analysis of the Ontario grain and oilseed sector. B. Doidge
- Effects of exchange rate variations on international competitiveness of major agri-food products in Ontario. R. Sarker
- Enhancing the effectiveness of environmental management systems from bio-physical and socio-economic perspectives: Farming Systems approach. C. Swanton

Riparian and wetland development

- Design tools for riparian vegetative filter strips incorporating characteristics of the contributing watershed. R. Rudra
- Regional waster water treatment technologies. C. Weil

Site specific management

- Identifying management units for site-specific nitrogen management: Characteristics of the spatial and temporal stability of yield patterns. I. O'Halloran
- A GIS and remote sensing system for agroecosystem monitoring and site specific crop management of agricultural Ontario. R. Protz
- Plant spectral analysis during early crop growth for site-specific nitrogen fertilizer management. P Voroney

Supply chain management

- Evaluating the effectiveness of strategic alliance in agri-food and related industries. D. Sparling

Waste application and treatment

- Optimizing the value of paper mill biosolids as a soil ammendment on agricultural land in Eastern Ontario. B. Curnoe
- Application of ground penetrating radar for design and testing of waste water trenches and measuring spatial variability of soil moisture. G. Parkin
- Treatment of farmstead runoff using chemical coagulation and flocculation. C. Weil
- Conditioning of degraded and marginal soils with paper mill biosolids prior to planting grapes, peaches and agricultural crops. P. Voroney
- Biosolid application on agricultural land. B. Hale
- Field and model studies of septic tank leaching bed performance. D. Joy

Water taking priorities

- Field validation of the soil temperature and water regime components of the SHAW model under Ontario geoclimatic conditions. R. McBride
- Enhancing capacity to address variability and uncertainty in rural water supplies. R. Kreutzwiser

Open

Competitiveness:

- Economic analysis of farm level competitiveness with respect to inputs, cost of production and sustainability. K. McEwan
- Agricultural sector viability and policy analysis. G. Brinkman

Biophysical:

- Field validation and sensitivity analysis of the WheelVB model. R. McBride
- Prevention of water resources contamination with potentially pathogenic faecal bacteria from manure following field application. M. Goss.
- Two and Three dimensional imagery of soil space. R. Protz
- Molecular typing of *Cryptosporidium parvum* oocysts using amplified fragment length polymorphism (AFLP). H. Lee
- Modeling the fate of gaseous agricultural pollutants. G. Edwards

APPENDIX IV

Issue Champion and Other Reports

Appendix IV – Issue Champion and Other Reports
- Nutrient Use Efficiency
- Manure Management
- Soil and Crop Management
- Research Activities at ECORC
- Field Crops, Soil and Environmental Quality Team – SCPFRC
- Research Activities within Ontario Conservation Authorities

"Nutrient Use Efficiency" Issue Champion Report to OSWARSC: 2000

Ivan O'Halloran, Ridgetown College, University of Guelph

Background:

Efficient use of nutrients continues to remain as a key component to the profitable and environmentally sound production of crops. Ensuring a sufficient supply of nutrients for optimum crop yield and quality is a relatively straight forward task. The challenge is to not simply optimizing yield or quality, but rather the maximization of producer profits and the minimization of nutrient losses to other, potentially sensitive, environmental areas. Increasing input costs and lower commodity prices are increasing the producer's awareness of the importance of proper fertility management. Nutrients applied in excess of crop requirements are often at greater risk of being leached into groundwater, carried with runoff into surface water, or lost to the atmosphere and thereby contributing to greenhouse gas accumulation.

While there is a strong basic knowledge about managing nutrients for efficient use, there are also some significant gaps in our knowledge. These gaps may relate to recommendations for crops which did not receive high research priority in the past, or to entirely new crops. Management practices on farms have also changed, which may require research to keep fertilizer recommendations current, or to at least validate the existing recommendations. Newer issues, such as greenhouse gases, may also impact on the way nutrients and farming systems as a whole are managed.

Progress and research activity over past year:

Progress continues to be made on the understanding of factor influencing the availability of nutrients contained within manure and their interactions with soil-plant systems. Other projects pertaining to the management of manures can be found in "Manure Management Issue Report".

Several studies have been completed on the nutrient availability from biosolids. These have provided good information about the specific materials studied, but unfortunately the diversity of materials used does not allow direct comparison between different biosolids. Much of this research has been funded by the biosolid generator, and studies are continuing in this area.

Work is continuing in the fertilization of cole crops (N, Ca, S), muck crops, garlic (foliar sprays), tomatoes, berries crops, apples, grapes and peaches, as well as studies on placement of lime and potash in no-till systems. While some of these studies are just starting, several are well underway and can be expected to yield results in the next year or two.

Barriers to progress:

The partial listing of research projects appended to this report is considerably larger than last year. This should not be interpreted as an increase in activity per se, but rather a "more complete" partial listing. As indicated in my 1999 report, the number of projects does not necessarily reflect the total amount of effort directed to this issue. Most researchers are only able to commit a small part of their time to fertility and nutrient use efficiency research because of other commitments. For example, many of the fertility projects conducted on berry, large fruit and other horticultural crops appears to be only a small component of the over management of these crops. The small number of researchers also limits the opportunities for collaboration and

co-operation, making each researcher even less effective. Recent staff appointments at the U of G (Plant Agriculture: Bill Deen, Land Resource Science: John Lauzon and Richard Heck) will increase the amount of effort in this area, as these individuals fill positions that have been vacated within the past three years.

Sub-issues: (These remain unchanged from the 1999 report)
* Horticultural crops - lack of recommendations research, diversity of crops and soils which should each be researched separately still remains an issue.
* Greenhouse gases, and the link to nutrient applications
* Prediction of organic N release - work is progressing in this area for major field crops systems
* Fertilizer applications on sensitive soils
* Nutrient recommendations for specialty crops and new crops
* Validation of recommendations

Research Recommendations:
The 1999 annual report by OSMRSC to OSWARSC contained eight recommendations dealing solely or partially with the issue of nutrient use efficiency. Briefly stated these research recommendations pertained to the improvement of NPK fertility management of field, horticultural and tobacco crops; improvement of secondary and micronutrient fertilization of field and horticultural crops, prediction of available N from organic sources; development of a N test for organic soils, nutrient recycling in greenhouse nursery operations; effectiveness of urease inhibitors as a means to improve fertilizer use efficiency and crop productivity; improve management, productivity and profitability of field crop production by increasing our understanding of the temporal and spatial variability of soil properties in agricultural fields and the development of multi-element extractants suitable for Ontario soils. (See Recommendations 6, 7, 8, 9, 10, 11, 12, and 18 on pages I-20 to I-27 in OSWARSC 1999 Annual report to OASCC for further details).

Current Status:
The partial listing of research activity in the area of nutrient use efficiency indicates that for the most part there is continued or new activity addressing most of the recommendations raised. I am not aware of any Ontario research focused on the onerous task of developing a multi-element extractant or the development of a N test on organic soils.

The diverse nature of horticultural crops has resulted in fairly scattered activity of fertility research in this sector. In many instances fertility issues are not the main focus of the study, and so one should not necessarily consider the number of projects list to be a clear indication of the effort devoted to this area. Undoubtedly there will continue to be a greater need for fertility research in these areas than resources. Research is continuing on fertility issues associated with greenhouse and nursery container stock systems.

Research on field crops remains focused on the crops occupying the largest acreage, namely corn and soybean. Several new projects have been initiated in the area of variable response of corn to N application and the impact on gaseous N losses and nitrate leaching. These results may also have some application in terms of the fertilization of small grain crops. Some studies on N and P fertility of winter wheat are continuing.

Level of Activity: The level of activity in certain areas tends to shift slightly, following the availability of funds. Overall, it undoubtedly reflects the numbers of people and dollars invested in research. Theere has been some increased activity in areas of N use efficiency and impacts of management systems on greenhouse gas production.

Cooperation and Collaboration: There continues to be a reasonable collaboration for the most part between individuals at different institutions, although there is room for improvement in terms of the teams of individuals and institutions involved.

Gaps: The majority of the effort has been placed on the issue of N management and its impact on the environment with relatively very little effort being placed on other nutrients. Research is still needed on other nutrients and/or horticultural crops and this is likely to remain a need for many years to come.

Partial Listing of Research Projects Related to Nutrient Use Efficiency

Ball-Coelho: AAFC

Nitrogen placement for no-tillage systems (ended 1999)

Modelling nitrate leaching (on-going)

N test in relation to crop response to side-dress manure applications (99-02)

Manure application systems and nitrate leaching (00-01)

Beyaert: AAFC

Impact of agronomic practices on soil quality, environmental quality and crop productivity in coarse-textured soils in Ontario (long term)

Nitrogen mineralization of the rye rotation crop as affected by nitrogen regime and the effect on nitrogen fertilizer use in tobacco production (ended 2000)

Ginseng N, P & K fertilizer rate trial (ended 2000)

Nitrogen fertilizer rate trial for forage sorghum and forage millet (ended 2000)

Blom: U of G

Production Management of Floricultural Greenhouse Crops (98-02)

Chong: U of G

Environmentally-friendly Nursery Production Research (98-02)

Cline: U of G

Orchard Management And Physiology of Tree Fruit Crops, Particularly Apple (98-02)

Curnoe: U of G

Optimizing soil and crop management practices for the productive soils in Eastern Ontario (97-99)

Optimizing the Value of Paper Mill Biosolids as a Soil Amendment on Agricultural Land in Eastern Ontario (99-03)

Dale: U of G

Breeding and Management of Berry Crops (98-02)

Deen: U of G

Integration of Crop Rotations, Continuous Versus Rotational Tillage Systems, And Nutrient Management For Sustainable Corn And Soybean Production (98-02)

Integrating Zone Tillage and Fertility Placement Techniques to Develop and Efficient, Crop-Based Nitrogen Management System

Derkacz: U of G

Improvement of fruit production through improvement of soil fertility and fruit tree nutrition (98-02)

Effect of management on the availability of nutrients to orchard trees and vines (97-01)

Dixon: U of G

Management and measurement techniques for greenhouse nutrient recycling (98-02)

Drury: AAFC

The development of decision making tools for use in crop management systems which improve soil and water quality and reduce soil gas emissions for southwestern Ontario processing crops.

Fisher: U of G

Variety Development/evaluation and Production Management for Efficiency And Profitability in Juice, Wine and Table Grapes in Ontario (98-02)

Vineyard Management for Vinifera Cultivars in Ontario (98-02)

Gordon: U of G

Understanding Crop Yield Dynamics in a Temperate Intercropped System (98-02)

Goss: U of G

The efficacy of mycorrhizal associations on early soybean growth and N fixation (99-00)

Investigation of the potential to enhance mycorrhizal efficacy and associated nitrogen fixation in soybeans (00-02)

Development of a single integrated computer program for the management of manure, biosolids and mineral nutrients (99-00)

Evaluation of best management practices for increasing nitrogen use efficiency on farms (99-01)

Evaluation of Extraction Techniques for Estimating Potentially Available N from Manures to Crops (96-99)

Gillard: U of G

Soybean and Canola Management and Variety Development (98-02)

Gregorich: AAFC

Dynamics of N Availability and Soil with Various Nitrogen Amendments

Managing Soil Carbon and Nitrogen Resources Sustainable Crop Production

Groenevelt: U of G

Steady-State Baseline Nitrate Leaching (99-02)

Hsiang: U of G

Turfgrass management to reduce inputs and increase stress tolerance (98-02)

Kay: U of G

Prediction of Available N from Soil Organic Matter and Residual Legume Crop N (99-00)

Identification of N management units using organic carbon (00-03)

Interpreting Yield Variation from Soil Structure and Soil Water Parameters

Liptay: AAFC

Improvement of knowledge of i) control of growth of transplants and vegetable crops, and ii) maximizing vegetable yield and quality and iii) composition of vegetable crops.

Tomato Fertigation Research (Continuous Nutrient Application Through Drip Lines)

Lumis:

Optimizing fertilization and irrigation for container-grown nursery crops (98-02)

Madill: U of G

Strawberry Production in Eastern Ontario (98-02)

McDonald: U of G

Muck Vegetable Crop Management Studies (98-02)

McKeown: U of G

Vegetable and Non-traditional Crop Management and Physiology (98-02)

O'Halloran: U of G

Identifying Management Units for Site-Specific Nitrogen Management: Characterization of the Spatial and Temporal Stability of Yield Patterns (99-02)

Variability of Soil Phosphorus (98-02)

Impact of Manure and Fertilizer Phosphorus Applications on Phosphorous Availability (99-01)

Influence of variable rate N fertilization on nitrous oxide emissions (00-02)

Within field variability of corn grain quality: Influence of topography and rate of N fertilization (00-01)

Development of a Multi-Scale Site Specific Nitrogen Management System (SSNM) (00-05)

O'Sullivan: U of G

Crop Management Studies for Processing Cucumbers and Other Vegetables (98-02)

Protz: U of G

A GIS and remote sensing system for agroecosystem monitoring and site specific crop management of agricultural Ontario (99-01)

Rowsell: U of G

Northern Ontario Cereal Research (98-02)

Northern Ontario Oilseed And Pulse Research (98-02)

Skog: U of G

Improvement of Postharvest Quality of Ontario-grown Vegetables (98-02)

Smid: U of G

Performance evaluation and management of corn and cereals in south western Ontario (98-02)

N fertilization of hard red winter wheat (industry funded)

Sullivan: U of G

Improvement of Economic Potential for the Production of Peaches and Nectarines (98-02)

Swanton: U of G

Protein and Oilseed Crop Physiology and Management (98-02)

Tan: AAFC

The Development of decision making tools for use in crop production systems that ensure environmental quality through management of soil and water resources

Voroney: U of G

Plant spectral analysis during early crop growth for site-specific nitrogen fertilizer management (99-00)

Management of Municipal Sewage Applications to Agricultural Land (96-00)

Application of Paper Mill Wastes to Agricultural Land

Conditioning of degraded and marginal soils with paper mill biosolids prior to planting grapes, peaches and agricultural crops (99-02)

Vyn: (projects still at U of G)

Potassium (K) Placement for No-till Crop Production (ended in 2000)

Enhancing Corn Productivity Through Zone-Tillage on Heavier Textured Soils (on-going?)

Wagner-Riddle: U of G

Greenhouse gas emissions, removal of air pollutants and nitrate leaching in management systems designed for carbon sequestration (99-03)

Risk Assessment & Economic Evaluation of Environmental Damage Associated with Livestock Manure - Dietary Strategies & Handling Alternatives (99-03)

N Balance of Turfgrass (96-99)

Ammonia & N Gas Loss Resulting from Manure Application (96-99)

Young: U of G

Soil Management Research in Southwestern Ontario (98-02)

Lime Application in No-till Systems (98-99) (continuing on one site till 2001)

Zandstra: U of G

Cultural Management and Cultivar Evaluation of Fresh Market and Processing Vegetables (98-02)

Zhang: AAFC

Nitrogen Fertilization Management for Fresh Market Sweet Corn Grown with Plastic Mulch

The Response of Selected Soybean Varieties to Various Potassium Sources

Isoflavone-Rich Soybeans: Studies of Genetic, Soil Fertility and Disease Factors Affecting Isoflavone Accumulation

Manure Management

Michael Goss, Manure Management Issue Champion
University of Guelph
22 November 2000

1. Introduction

Manure issues continue to be the focus of much of the media attention. Attention was sharply focussed on Walkerton by the death of seven people and acute illness in two thousand others who drank piped water contaminated with Escherichia coli O157:H7. The source was traced to a farm with a small beef operation using genetic finger-printing. Government response has been twofold. Firstly to ensure that piped water supplies are properly treated through chlorination, make sure that the water is properly tested, and that the result of the testing is made known to the appropriate authorities. Secondly, they have hastened legislation which will impose mandatory standards of operation on agricultural operations. There have been no significant monies made available provincially to speed up research aimed at prevention of contamination, although some is available in the 2001 funding for Special Research. Federally, the initial response was to blame 'factory farming', but before the crisis in Ontario it had announced its desire to establish a Network Centre of Excellence on Clean Water. Two proposals are currently being evaluated: one centred at Waterloo, and one at McGill. Agricultural aspects feature more prominently in the latter.

Some additional funding did become available for climate change research in agriculture, and a significant amount has been put to supporting work on Greenhouse Gas Emissions from manure management systems.

There appears to be increased interest in on-farm and regional bioreactors. The increased price of oil has altered the economics, and the general concern about manure management may be a further incentive. I do not believe that this requires more research, except that it would be useful to know more of the economics of transport associated with manure. Can the energy produced in a regional plant cover the cost of fuel to transport the manure?

2. Research Activity

2.1 Enhanced Partnership

In research on manure funded through the Enhanced Partnership between OMAFRA and the University of Guelph, there has been little change in 2000. Two projects have ended, one in which MCLONE4 and NMAN2000 were put together on the same platform (Ontario Manure Management Suite), and seamlessly transfer data between themselves. NMAN replaces the field application module in MCLONE4. Manure storage sizing in the Suite uses the OMAFRA program that was linked to NMAN.

The other project was aimed at off-farm economic and social impacts of manure. The final reports on these two projects are due in January 2000.

Work on P transport through soil is due to be completed in April 2001.

2.2 OMAFRA Special Research Funding
Two Special Research Funding projects consider manure: a project on the development of a Nitrogen Index (Goss et al., University of Guelph & OMAFRA), and a watershed management project (South Nations Conservation Authority).

2.3 Other University activity
Ron Fleming has completed literature reports on the security of concrete manure storages, and on the winter spreading of manure.

Ridgetown has work ongoing studying GHG emissions from composting liquid swine manure. They are also about to investigate pulp mill waste as a carbon substrate for composting manure.

The following project was funded through the Climate Change Funding Initiative in Agriculture:

Improved Greenhouse Gas Emission Estimates From Manure Storage Systems Claudia Wagner-Riddle, University of Guelph

(The following lists manure-related work funded outside of Ontario:
Reduction of GHG Emissions from Dairy Production Systems and Poultry Manure and Its Impact on Agricultural Sustainability Jim Shelford et al, University of British Columbia

Environmental Performance of Alternative Dairy Production Systems Alan Fredeen et al, Nova Scotia Agricultural College

Examination of Environmentally and Economically Sustainable Management Practices in Forage Based Beef Production Systems Karin Wittenberg/Kim Ominski, University of Manitoba

Feedlot GHG Emissions: Effect of Diet and Manure Storage Systems Karin Wittenberg et al, University of Manitoba

Reduction of GHG Emissions in Swine by Diet Manipulation, Measurement of GHG Emissions and Odour from Swine Manure derived from Standard and Modified Diets Ron Ball, Jerry Leonard et al, University of Alberta

Greenhouse Gas and Odour Emissions from Swine Operations in Quebec and Saskatchewan: Benchmark Assessments and Selective Mitigation Processes Claude Laguë et al, Univ of Saskatchewan

Dairy Production and Poultry Manure Management Systems Shelford, University of British Columbia

Feedlot GHG Emissions. Wittenberg, Univ of Manitoba

Reduction of GHG Emissions in Swine Ball, Leonard et al, University of Alberta)

The report commissioned by Ontario Pork on the leaking from manure stores by Komex, indicated that there might be some kind of plume associated with 6 of the 50 sites. University of Waterloo (D. Rudolph) is investigating these in depth, but no results are available.

2.4 Agriculture Agri-Food Canada

London
Important work on the ecology of Escherichia coli after shedding. This work deals with the survival of E. Coli during manure storage, and after land application. It is linked with other work investigating the impacts on the environment of the excretion of antibiotics and microbes that have been shed by animals receiving treatment by antibiotics or being fed antibiotics to enhance growth. Another aspect is the excretion of endocrine disrupting compounds by animals, and their fate in the environment.

Efficient manure utilization using precision injection at the time of sidedressing is underway.

Harrow
Work continuing on the application of composted manure to agricultural land, and the nutrient availability to crops.

Ottawa
Work on the prediction of nitrogen availability from animal manures has continued.

2.5 OMAFRA
Research is aimed at improving the recommendations for land application.

3. Research Issues
There are major gaps in the understanding of the importance and fate of endocrine disrupting compounds from animal manure. Information on the fate of antibiotics fed to animals is also limited.

There needs to be more concerted effort to develop the capability to predict the fate of pathogens shed by farm animals. There is some activity, but it is limited, and more is needed. The hydologically isolated plot facility at Alfred would be useful for this work. Riparian zone information is required to allow the prediction of filter strip capability to remove pathogens, endocrine disruptors and other manure contaminants.

The potential economic impacts of developing wellhead protection zones, needs to be reviewed.

Soil & Crop Management Research in Ontario

Prepared by: C.F. Drury

Greenhouse & Processing Crops Research Centre (GPCRC)
Agriculture & Agri-Food Canada
Harrow, Ontario

Soil and Crop Management Research in Ontario can be divided into the following research areas:

1. Tillage research to overcome limitations of no-till in clay and clay loam soils

2. Organic amendment applications to improve soil quality by increasing organic matter, improving soil physical properties and/or enhancing nutrient availability.

3. Crop rotation systems to improve soil quality and reduce diseases.

Water table management and irrigation technology to alleviate drought stress and thereby improve crop growth, enhance nutrient uptake and/or improve water quality.

Greenhouse gas/Carbon sequestration research to improve soil and environmental quality.

Soil quality & process studies

There are 38 projects in Soil and Crop Management Research identified in the attached list and 13 of these projects are new in 2000. There are 12 tillage studies which represent about 1/3 of the projects in Soil and Crop Management Research and 5 new tillage projects have been identified in this area. These include 2 new studies addressing the long-term effects of tillage on soil quality and crop productivity (Guelph and Ridgetown) which when combined with the long-term tillage study at Woodslee should give us a good overview of the long-term effects of tillage in Southern Ontario. A fall strip tillage study for corn has also been initiated (U. of Guelph) and a new study has been started which focuses on the identification of soil-related limitations to no-till in Ontario. The influence of tillage to advance the maturity of full season white corn is also being studied (Ridgetown).

There are 3 new crop rotation studies identified in the list: one which addresses the long-term effects of rotation on soil quality and crop productivity, the second study investigates short-term crop rotations for soybeans and the third study examines rotations, rotational tillage, and nutrient management effects on corn and soybean production .

There is one new amendment study which examines the effects of various soil amendments on soil physical properties.

A new water quality study investigates the water quality effects of applying composts to agricultural land. In addition, a wetland has been constructed and is connected to an adjacent field via tiles so that water, nutrients and pesticides can be captured during wet runoff periods and reused via

irrigation during dry periods. This integrated wetland/agriculture system is designed to be an environmentally friendly 'closed' system.

Two new GHG projects have been identified. One utilizes a site specific N application approach to evaluate if this technology can also be used to reduce greenhouse gas emissions. The second greenhouse gas study investigates the feasibility of using deep N placement as a method of reducing N_2O losses in conservation tillage systems (Woodslee).

Soil and Crop Management Research Studies in Ontario

Tillage Research

1. Environmental evaluation of zone tillage, no tillage, and conventional tillage systems for corn & soybean production in Southwestern Ontario. T Vyn, (U. of Purdue), C.F. Drury (GPCRC), C.S. Tan (GPCRC), W.D. Reynolds (GPCRC), T.W. Welacky (GPCRC), A.S. Hamill (GPCRC), S.E. Weaver (GPCRC) and T.O. Oloya (GPCRC).

Evaluating short versus long-term no-tillage and conventional tillage systems for soybean and corn production on a clay loam soil in Southwestern Ontario. C.F. Drury (GPCRC), W.D. Reynolds (GPCRC), C.S. Tan (GPCRC), T.W. Welacky (GPCRC), C.A. Fox (GPCRC), and E.G. Gregorich (ECORC).

Tillage (conventional, no-till, chisel and zone tillage) systems for processing tomatoes John O'Sullivan, (U. of Guelph), C. Swanton (U. of Guelph) and T. Vyn (U. of Purdue).

Soil structure characterization and evaluation of tillage practices with respect to physical and biological influences in structure development. C. Fox (GPCRC).

Effects of cropping and tillage practices on soil quality. R. Beyaert (SCPFRC) and P. Voroney (U. of Guelph).

Evaluation of zone tillage effects on limitations to successful no-till corn production R.P. Beyaert (SCPFRC), B. Ball-Coelho (SCPFRC), R. Chapman (SCPFRC) and R. Roy (SCPFRC).

Quantifying the detrimental effects of improperly timed cultivation under no-till and conventional till practices. W.E. Curnoe (KCAT - U of Guelph) , C. Topp (ECORC), E. Gregorich (ECORC), D. Lapen (ECORC), N. McLaughlin (ECORC).

*Long-term effects of tillage system on soil quality and crop productivity. B. Deen (U. of Guelph).

*Identifying soil related limitations to no-till production in Ontario. Bill Deen (U. of Guelph), W.E. Curnoe (KCAT - U. of Guelph), Clark Topp (ECORC), Ken Janovicek (U. of Guelph), Tony Vyn (U. of Purdue)

*Evaluation of fall strip tillage systems in corn. B. Deen (U. of Guelph), G. Stewart (OMAFRA)

*Long term comparison of tillage systems under corn and soybeans" D.S. Young

**Use of Soil Tillage to advance the maturity of full season white corn" D.S. Young (RCAT - U of Guelph)*

Crop Rotation Research

Long-term effects of fertilization and rotation on soil quality and crop productivity. C.F. Drury (GPCRC), C.S. Tan (GPCRC), W.D. Reynolds (GPCRC), E.G. Gregorich (ECORC), P. Groenevelt (U. of Guelph) and H. Dadfar (U. of Guelph).

Overseeding cereal rye into standing corn to test effects on crop yields and movement of nitrates. B. Ball Coelho (SCPFRC) and R.C. Roy (SCPFRC).

Effect of rotational crops on suppression of populations of P. penetrans. B. Ball Coelho (SCPFRC), E. Riga and R.C. Roy (SCPFRC).

Corn root systems under long-term fertilization and crop rotation: a minirhizotron study. T.Q. Zhang, C.F. Drury, C.S. Tan, W.D. Reynolds (GPCRC).

**Long-term effects of rotation on soil quality and crop productivity. B. Deen (U. of Guelph).*

*Short term crop rotations for soybeans" D. S. Young, T. W. Welacky (GPCRC) and A. Tenuta (OMAFRA)

*Integration of crop rotations, continuous vs rotational tillage systems and nutrient management for sustainable corn and soybean production. B. Deen (U. of Guelph) and W.E.. Curnoe (KCAT - U of Guelph).

Organic Composts & Paper Mill Biosolids Research

An evaluation of agronomic and environmental effects of application of composted source separated solid waste to agricultural land. C.F. Drury (GPCRC), W.D. Reynolds (GPCRC), C.S. Tan (GPCRC), R. Fleming (RCAT, U. of Guelph) and C. Fox (GPCRC).

Effects of compost on processing crop production and soil and water quality under large scale no-till and conventional-till fields. C.S. Tan (GPCRC), C.F. Drury (GPCRC), W.D. Reynolds (GPCRC), and T.Q. Zhang (GPCRC).

Compost materials for turfgrass. Ken Carey and Greg Boland.

Optimizing the value of paper mill biosolids as a soil amendment on agricultural land in eastern Ontario. W.E. Curnoe (KCAT - U of Guelph).

**Impacts of Amendments on Soil Properties Contributing to Improved Crop Production in Fine-*

Textured Soils W.D. Reynolds, X. Yang, C.F. Drury, and C.S. Tan (GPCRC).

Irrigation & Water Table Management Systems

Effects of controlled drainage/subirrigation on processing tomato, corn and soybean yields and water quality at field scale. C.S. Tan (GPCRC), C.F. Drury (GPCRC), J.D. Gaynor (GPCRC) and T.W. Welacky (GPCRC).

Processing tomato production: determination of the effect of irrigation and fertigation on yield and fruit solids on a field scale. A. Liptay (GPCRC), C.F. Drury (GPCRC), C.S. Tan (GPCRC), W.D. Reynolds, and T. Jewett (GPCRC)

Irrigation and water budgets for turfgrass. Bob Sheard and Gary Parkin (U. of Guelph).

Measurements of agricultural impacts on water quality, and the development of management practices to protect water resources. R. Fleming (RCAT - U. of Guelph).

**Use of Composts to Reduce Fossil Energy Consumption and the Negative Environmental Impacts of Field Crop Production W.D. Reynolds (GPCRC), C.S. Tan (GPCRC), C.F. Drury (GPCRC), and T.W. Welacky* (GPCRC).

*An Integrated Land-Water-Crop Management System for Mutual Improvement of Crop Production and Wildlife Habitat.C.S. Tan (GPCRC), C.F. Drury (GPCRC), W.D. Reynolds (GPCRC), T.Q. Zhang (GPCRC) and A. Mack (Essex Region Conservation Authority).

Greenhouse Gas/Carbon Sequestration Research

1. The influence of carbon sources, water and oxygen effects on nitric oxide and nitrous oxide emissions from soils. C. F. Drury (GPCRC), D.J. McKenney (U. of Windsor), S.W. Wang (U. of Windsor).

Diffusion systems within and above tall vegetation G. Thurtell (U. of Guelph).

**Site-specific application of fertilizer N for reducing greenhouse gas emissions" R.G. Kachanoski (U of S), R. Simard (AAFC), I.P. O'Halloran (U of G), C. McKenzie (Alberta Agriculture) and D. Rolston (U of Cal., Davis)*

*Reduction of Fossil Energy Consumption and GHG Emissions Through Conservation Tillage and Deep Nitrogen Placement. C.F. Drury (GPCRC), C.S. Tan (GPCRC), W.D. Reynolds (GPCRC), T.W. Welacky (GPCRC), C.A. Fox (GPCRC)

General Soil & Crop Management Research

1) Optimizing soil and crop management practices for soils in E. Ontario. W.E. Curnoe (KCAT - U. of Guelph), C. Topp (ECORC), E. Gregorich (ECORC), D. Lapen (ECORC) and N. McLaughin (ECORC).

2) A farming systems approach to assessing the sustainability and health of food production systems in Ontario. C. Swanton (U. of Guelph).

3) Evaluation of environmental impact of continuous vegetable production in organic and conventional farming systems. J. Tolman (SCPFRC), C. Fox (GPCRC) and E. Topp (SCPFRC).

4) Development and measurement of soil parameters that indicate and/or quantify soil physical quality for high output and environmentally sustainable field crop production. W.D. Reynolds (GPCRC), C.F. Drury (GPCRC), and C.S. Tan (GPCRC).

Research Activities at ECORC Presented to OSWARSC Nov 23, 24, 2000. Guelph, Ontario

Manure Management:

Also see ECORC projects 21-24,43

1. Trends in corn production and soil N after long-term repeated application of diary manure.

B. L. Ma, L. M. Dwyer and E. G. Gregorich - ECORC, AAFC, Ottawa

Dairy farm manure has been applied as the sole N source for corn (Zea mays L.) production in Ontario, but if it is applied in amounts in excess of crop N requirements, soil total N concentration and associated with changes in chemical and physical properties may result. A long-term field experiment with corn monoculture under different fertilizer and manure amendments was conducted on a Brandon loam soil (Orthic Humic Gleysol) on the Central Experimental Farm at Ottawa. The objectives were to i) quantify fertilizer and manure application effects on corn yield and N uptake; and ii) monitor total N balance in the soil-plant continuum following 7 years of continuous corn production. Results up-to-date indicate that grain yields of manure treatments in the earlier years were generally lower (5 to 15 %) than the 200 kg N ha^{-1} fertilizer treatment. During the last several years, the grain yields in all manure treatments were equal to or slightly greater (6 to 13%) than those in the mineral fertilizer treatments. Manure application increased corn N uptake and grain yield. The NUE, based on mineral N levels in the spring, was greater for all of the manure treatments than for the 200 kg N ha^{-1} treatment. Grain yields and soil profile total N for the 100 kg N ha^{-1} treatment, a sub-optimum N rate, were not significantly different than those from the 200 kg N ha^{-1} treatment. Over the seven years of the study stockpiled manure treatments maintained (low rate) or substantially increased (high rate) soil total N content.

Nitrogen Use Efficiency:

Also see ECORC projects1,7,11,13

2. Evaluating Field-Scale Methods for Identifying Nitrogen Management Units.
E.G.Gregorich, C. Topp, D. Lapen, B. Ma, (ECORC); W.E. Curnoe (Kemptville College); Ontario Corn Producers' Association

Improved methods for on-site definition of field management units to respond to residual N variability will help improve the nitrogen use efficiency and provide farmers with economically and environmentally sound management practices. The objective of this study is to evaluate field-scale methods to identify field management units which would respond to residual N variability. In this study methods to measure in-field N availability and variability, including tests for available soil N, remote sensing (e.g., TDR), and soil physical properties that affect soil biological activity will be evaluated. The spatial variability of soil physical properties, nitrate levels and yield will be characterized by evaluating the relationship among them and determining the factors responsible for yield variability. Spatial units of yield response based on soil factors and farm management practice will be determined using geostatistics.

3. Seasonal trends of crop growth efficiency – Radiation and water use efficiencies as a function of nutrient management and climate.
E Pattey, I.B. Strachan – AAFC, Ottawa, cooperation with J. Boisvert (AAFC, Research Branch), 1998

Improved nitrogen management is one of the main challenges of precision agriculture where nitrogen rates are customized to fit local crop needs. This experiment shows that tools for assisting producers in making management decisions regarding nitrogen application rates need to include a weather component. The response of corn (Zea mays L.) to two rates of nitrogen, representative of the range used in variable nitrogen application, was assessed over a growing season by means of micrometeorological and hyperspectral reflectance techniques. The growing season was characterized by precipitation that was above normal in June but with rainfall deficits in July and August. Water use efficiency, defined as the ratio of daily net crop CO_2 uptake to evapotranspiration, was higher in the 99N area compared to the 155N area. Greater evapotranspiration, related to faster leaf expansion in the 155N area, was mainly responsible for the lower efficiency. Biomass accumulation, calculated from eddy-covariance CO_2 fluxes, was generally similar for the 99N and 155N application rates. Corn in the 155N area was more affected by water deficit during the active growing period than corn in the 99N area. This finding was supported by the results obtained through the measurement of a hyperspectral water band index. The recommended rate of nitrogen application did not induce an economically significant increase in grain yield, because of the rainfall deficit in July and August. This study was repeated in 2000, which had no water stress; data are being analyzed.

4. Crop-based Indicators for Monitoring Spatial Variability and Corn Nitrogen Management.
B. L. Ma, L. M. Dwyer, E. G. Gregorich, G.C. Topp, N. McLaughlin - AAFC, Ottawa. Collaborator: B. Deen, I. O'Halloran - U. Guelph; G. Stewart - OMAFRA .Partially funding from: OCPA

Up-to-date research indicates that in Ontario, corn yield response to nitrogen (N) amendment is poorly correlated with soil mineral N content preplanting. It is hypothesized that the precision of N application can be improved by basing N fertilizer recommendations on crop-based indicators that account for spatial and temporal variability. Field experiments with different management systems (tillage, hybrids, N amendments, and management zones) have been conducted at Ottawa and University of Guelph. Canopy reflectance and leaf chlorophyll content are measured at the time of side-dress N application. Corn N requirement is then determined based on defined relationships between these measurements and corn N stress. This "system" would fit particularly well where potassium and phosphorus are applied in the fall during fall semi-ridge tillage operations thus enabling non-limiting rates of N to be applied in the row zone. Preliminary analysis of data shows canopy reflectance measured at early stages has potential to be used as an accurate, fast repeatable indicator for corn N management.

5. Nitrogen credit of alfalfa or soybean residue to corn using N15 labelling approach.
B. L. Ma, L. M. Dwyer, E. G. Gregorich and M. J. Morrison - ECORC, AAFC, Ottawa.

The discrepancy in N credits of preceding legume residue to a following corn crop and a need for such information in developing sustainable production systems in eastern Ontario provoked this study. A field experiment was conducted with soybean and alfalfa crops labelled with ^{15}N fertilizer during legume growing seasons. The objectives were to trace the fate of applied ^{15}N, to quantify N accumulation in legumes, translocation through the soil to the maize crop, and to determine the direct N credits to maize. Our data show that i) corn yields are greater when following alfalfa or soybean than under continuous culture; ii) total plant N uptake of corn was up to 130 kg N ha^{-1} when following soybean, and up to 170 kg N ha^{-1} when following alfalfa, of which 80% is accumulated in the grain; iii) soybean residue contains at most 40 kg N ha^{-1} whereas up to 100 kg N ha^{-1} of alfalfa residue was plowed down; and iv) the N credit of soybean to the following maize crop is about 15 kg N ha^{-1} and up to 45 kg N ha^{-1} of alfalfa N was directly contributed to maize.

6. Nitrogen management for bread wheat production in Eastern Canada.
B. L. Ma, H. D. Voldeng, J. Fregeau-Reid, R. Padenya and L. M. Dwyer - ECORC, AAFC, Ottawa.

Bread wheat quality is mainly determined by genetics but management practices can influence end-use quality. An on-going multi-site-year study with 8 or 10 varieties treated with different levels of N fertilizer was initiated in 1998 with the objectives to assess the physiological mechanisms associated with efficient N use and grain protein, and to develop a fertilizer technology package for bread wheat production in Eastern Canada. A separate experiment with two contrasting varieties was conducted for two years to investigate the movement of soil and foliar applied N within plant-soil continuum in relation to crop development, N uptake and use as affected by rate and method of fertilizer N amendments.

Water Management:

Also see ECORC projects 36

7. Development of regional-scale modelling to estimate the risk of water contamination from agricultural nitrogen under different policy scenarios.
T. Huffman, J. Yang, R. de Jong, S. Gameda, ECORC, Ottawa. 2000-2002.

Development of economic and regulatory policies and programs which support Agriculture and Agri-Food Canada's commitment to environmental health requires a comprehensive methodology to estimate the impacts of proposed initiatives on soil, air and water quality. This interbranch project is developing a land-based Decision Support System for the assessment of the impact of proposed policies on the risk of water contamination with nitrogen from agricultural production activities. The project is building on the Agri-Environmental Indicators work by improving the landscape-based regional nitrogen balance model and linking it to the output of AAFC's economic model CRAM (Canadian Regional Agricultural Model). The resultant integrated model will allow for the assessment of the linkages and sensitivities between economic goals and environmental sustainability.

8. Compilation of digital information of "known" and "probable" sediment-aquifers in Canada.
T. Huffman, D. Kroetsch, ECORC, Ottawa; H. Thorleifson, Natural Resources Canada, Ottawa; D. Trant, Statistics Canada; D. Coote, Agricultural Watersheds Associates, Stittsville. (Interdepartmental project) 1999-2001.

Preliminary identification of known aquifers in Canada, and a classification of their vulnerability to surface-source contamination. This project involves the assemblage of available maps of surficial and bedrock aquifers in agricultural regions of Canada from various sources and interpretation of the maps for probable risk of contamination by agriculture using a four-class system of: 1) High probability - surficial, high-yield, unconfined aquifers, and shallow high-yield bedrock aquifers overlain by thin, highly permeable overburden; 2) Moderate probability - surficial and bedrock high-yield aquifers overlain by thin, slowly-permeable materials, and buried valley aquifers overlain by various materials; 3) Low probability - moderate to low yield surficial and bedrock aquifers overlain by various materials; and 4) Areas without known aquifers having significant water yield. In those regions without maps from which the locations of aquifers can be estimated, literature searches and telephone interviews of federal, provincial and territorial government agencies are conducted to identify significant (i.e. 100,000 m^3 per yr or greater) groundwater use. Smaller withdrawals will be identified where the information is readily available. These points of withdrawal will be used as evidence of the existence of significant groundwater resources and will be recorded on maps. The Digital Chart of the World (DCW) base maps at a scale of 1:1 M are used to record and display this information.

Soil and Crop Management:

Also see ECORC projects 1, 2-5,25,28-30,32,34,38,39,43,44

9. Soil Strength/Compaction and Management Relationships with Crop Yields.
G.C. Topp, D.R. Lapen, E.G. Gregorich, N.B. McLaughlin, H.N. Hayhoe (ECORC); W.E. Curnoe (Kemptville College).

In eastern Canada, soil compaction is one of the most severe problems affecting crop yields. This study attempts to better understand compaction/yield associations within the context of soil oxygenation, bulk soil strength, soil water content, weather information, and management treatments.

Detailed field observations at the Winchester experimental station have identified that grain crops can respond variably to soil strength properties at various depths in the profile, and to various trafficking treatments. Corn responds less favorably to compaction, soybean yields are usually higher in compacted surface soils, and wheat yields appear to be optimal in soils neither highly or poorly compacted. Nevertheless, these relationships appear to be weather history related. Oxygen limitations as a function of compaction, and soil physical limitations to root growth are being explored. Preliminary analysis suggests soil degradation constraints on soil aeration have a significant negative impact on corn yields. Recommendations have been made on appropriate management treatments for corn, soybean, and wheat for various tillage, rotation treatments, and compaction risk zones.

10. Development of a Portable Combination Cone Penetrometer/Water Content Sensor.
G.C. Topp, D.R. Lapen, N.B. McLaughlin, E.G Gregorich; (ECORC);W.E. Curnoe (Kemptville College).Environmental Sensors Inc

A portable cone penetrometer/water content sensor (probe) has been developed at ECORC. The probe has been installed on a portable penetrometer for acquiring in situ and simultaneous measurements of cone penetration resistance and soil water content. These sensors are important tools for assessing in situ soil strength and water content in the field and for verifying on-the-go measurements like plow implement draft.

Research has been ongoing on the utility of in situ cone penetrometer/water content measurements at the Winchester experimental station. The combination tool has provided valuable information on surface and sub-surface soil physical properties affecting yields. Research also involves evaluating sensor stability under different environmental conditions, sensing fields in disturbed soil, and mechanical soil-probe interactions.

11. Management of Mycorrhiza in Corn Production.
S.D. Nelson.

Although mycorrhizal soil fungi are present in most soils used for Corn production in Ontario they are not managed to provide potential benefits to corn production. An experiment to evaluate the corn yield response to the placement of mycorrhizal inoculum under corn seeds during seeding has confirmed a positive yield response. Yield response to mycorrhizal inoculation was greatest in continuous corn (compared to corn after soybean or alfalfa) and under 100kg N/ha (compared to 0 and 200kg/ha, and composted and uncomposted manures). Various related investigations include: effect of rate of applied N on mycorrhizal colonization of corn roots, effect of rate and type of applied N and mycorrhizal treatment on expression of resistance to Fusarium ear rot, survey of corn hybrids and inbreeds for ability to accept mycorrhizal colonization, method for automation of mycorrhizal inoculum placement during seeding.

12. Development of measurement platforms and data quality assurance for ground-based hyperspectral reflectance.
I.B. Strachan, E. Pattey, D. Dow, A. Saumure, M. Lefebvre – AAFC, Ottawa, 1999

Measurements of hyperspectral reflectance for research purposes are difficult in tall crops such as corn. There is a need, however, to provide adequate spatial coverage of crop reflectance at the appropriate scale of the canopy-unit. To achieve this, the field spectroradiometer must be positioned some metres above the top of the canopy, viewing nadir and must remain portable. To this end, a measurement system comprised of a field spectroradiometer mounted beneath a tethered blimp inflated with helium was developed and tested in field corn. A notebook computer via a RS232 cable allowed real-time acquisition of crop reflectance spectra. The blimp was tethered to a climbing harness worn by the primary operator. A second person operated a guide rope while a third person operated the computer which triggered the spectroradiometer. The system was shown to provide reliable, clean spectra of canopy-scale vegetation, under low wind speed conditions.

13. Stress detection and yield prediction using ground-based and airborne hyperspectral reflectance.
E. Pattey, I.B. Strachan, N.B. McLaughlin – AAFC, Ottawa, cooperation with J. Boisvert (AAFC, Research Branch) J. Miller (York U.) and G. Daoust (Agrimage), 1998

Indices derived from hyperspectral reflectance spectra have the potential to be used as remotely sensed indicators of environmental stress in crops. This study uses canopy-scale measurements of hyperspectral reflectance to demonstrate the temporal and spatial patterns in crop development under imposed fertility (N rate) and environmental (water availability) stresses. Analyses to date have shown that individual reflectance-based indices have demonstrated the relative differences between application rates and identified both nitrogen and water stresses. No single index has been able to describe the status of the crop throughout the season. In the 1998 season (corn), canonical discriminant analysis provided accurate classification of samples by N rate during early, mid-, and late season conditions with overall success rates of 70%, 88% and 93%, respectively. Maps of hyperspectral indices from airborne sensors showed good correspondence with yield maps. Multiple years of data are required to demonstrate robust relationships between hyperspectral indices and crop ecophysiological status because of the interaction between environmental and nutrient stresses. Timing the collection of hyperspectral image data at early and late vegetative phase could enhance precision agriculture by allowing supplemental nutrient application and yield forecasting. This study was continued in 1999 with soybean and repeated in 2000 with corn; data are being analyzed.

14. Incorporation of satellite imagery into corn, wheat and soybean growth models to monitor regional crop development variability over the growing season.
T. Huffman, R. de Jong, S. Gameda, ECORC, Ottawa; C. Duke, U of Guelph; M. Anderson, PCIGeomatics, Hull. 2000-2002.

Commodity marketing, environmental sustainability assessment and land use planning require up-to-date information concerning the location, extent and condition of crop production activities. AGROMA is a software package designed to assist in analyzing and monitoring

agricultural production by combining remote sensing and spatial analysis functionality with crop growth models. AGROMA was originally developed for the Asian market, but PCIGeomatics sees potential for expanded markets in North America and is interested in reimplementing AGROMA with state-of-the-art information technology to function as a decision support system that includes an enhanced set of crop growth models for major Canadian crops. This project is assessing the suitability of various crop growth models (eg. CERES, DSSAT, EPIC) for incorporation into AGROMA, modifying source codes as required to add selected models to the suite available in AGROMA, identifying input requirements and developing calibration, validation and demonstration datasets.

15. Effects of Bt corn on soil organic matter quality and soil organisms.
H. Dinel, F. Meloche, L. Lesage T. Paré , M. Schnitzer and M. Saharinen, ECORC-AAFC., A-base.

One of the noticeable characteristics of Bt corn are very hard stems and also tendencies to exude different types of organic compounds. The objective of this project is to assess short and long term impacts of growing Bt corn on the quality of soil organic matter, soil pedofauna and pests (wireworms, potato stem borers and corn root worms). During the 2 000 growing season, Bt and non Bt corn plot soils were sampled and organic matter characterization will be done during the winter of 2001.

16. Benchmark Sites for Monitoring Soil Quality on Agricultural Land
S. Gameda, E. Gregorich, B. Vigier, T. Huffman, G. Coen (Lethbridge) - AAFC Ottawa 2000-2001.

Agricultural land management practices can substantially contribute to the deterioration of soil quality through degradation processes such as erosion, compaction, salinization and acidification. Twenty two sites were established as part of a national network of benchmark sites to quantitatively monitor changes in soil quality and identify environmental degradation indicators for major agricultural practices. The objectives of the benchmark project were: to provide a baseline data set for assessing changes in soil quality and crop productivity of representative farming systems; to provide a means for testing and validating predictive models of soil degradation and productivity; and to provide a means for evaluating the agricultural sustainability of farming systems in major agricultural regions of Canada. The selected sites were representative of: major soil zones and/or ecological regions; typical landscapes and/or broad textural grouping of soils; and major farming systems within each region. The Benchmark sites were monitored beginning in 1989. A set of reports, characterizing specific chemical, physical, mineralogical and morphological properties was prepared for each site. A summary report of all Benchmark sites, outlining methodologies utilized, site characterization and brief farming system descriptions is currently being prepared. In addition, a comprehensive dataset, comprising of baseline datasets from each Benchmark site, is being compiled for broad dissemination and use.

17. Mathematical modelling of the soil/plant/atmosphere system.
D. Stewart - AAFC, Ottawa

A better understanding of how radiation is intercepted by a crop and how this radiation is used to evaporate water and convert CO2 to plant carbohydrates will lead to improved water use efficiency and enhanced carbon accumulation (including enhanced yield) by a crop. Detailed mathematical models of radiation interception, evapotranspiration and plant carbon flows are being developed. Of particular interest are the feedback mechanisms which regulate leaf photosynthesis and transpiration. This research has implications for increasing economic and silage yields of crops as well as for increasing carbon accumulation in the soil and assessing the direct impact of higher atmospheric CO_2 levels on plant growth. As well, improved methods are being developed for calculating phenological development in corn and soybeans to aid plant breeders in developing varieties which will mature at a given location.

18. Prediction of yield variability using 'Crop Scan' instrumentation.
B. L. Ma, N. McLaughlin, B. Vigier, L. Dwyer - AAFC, Ottawa, 1999.

Plant canopy reflectance has been demonstrated to be correlated with aboveground biomass and leaf greenness and is possible to be used for in-season prediction of crop yields. Using Ontario Variety Performance Tests of winter wheat, spring wheat, barley and a soybean trial including 42 genotypes with 3 densities, canopy reflectance was measured several times after flowering to determine whether canopy reflectance measurement at any given stage of development discriminated high from low potential yields and a consistent relationship between yield and canopy reflectance expressed as normalized difference vegetation index (NDVI) can be used as an accurate, fast repeatable indicator for screening and predicting crop yields.

19. Assessing Soil Electrical Conductivity by TDR as an Estimate of Nitrate Levels.
E.G. Gregorich, G.C. Topp, AAFC, ECORC, 1999-2000

Time domain reflectometry (TDR) measures volumetric water content and bulk electrical conductivity (EC). Our objective was to explore the possibility for monitoring nitrate directly from the bulk EC determined by TDR. We measured EC and water content *in situ* and collected soil samples between June and September from three treatments: continuous corn without fertility amendment, continuous corn receiving high rates of manure (50 Mg/ha) and corn-soybean rotation. Soil water content amendments were either ambient conditions or raised and maintained at 90% water-filled pore space. The soil samples, taken at the time of TDR measurements, were immediately extracted with water (1:2, soil:water ratio) and EC and nitrate determined in the extract. Strong relationships existed between the extract EC and nitrate from the corn-soybean rotation but from the manured and unamended continuous corn treatments the relationship was not as strong. At the higher soil water content the correlation between these parameters measured on the extract was poorer. In addition, both the EC and nitrate levels were much lower, at < 50 % of the levels for ambient conditions. The seasonal trends of TDR-EC measurements and nitrate were the same in almost all treatments with relatively high levels in spring followed by a sharp decline during crop growth and relatively low levels in the autumn. This study indicated strong possibilities for using TDR-EC for nitrate level estimations. Additional theoretical and experimental work is intended to exploit this possibility.

20. Changes in Soil Carbon Under Long-term Maize in Monoculture and Legume-based Rotation
E.G. Gregorich, ECORC; C.F. Drury, GPCRC, 1999-2000

Legume-based cropping systems could help to increase crop productivity and soil organic matter levels, thereby enhancing soil quality, as well as having the additional benefit of sequestering atmospheric C. To evaluate the effects of 35 yr of cropping on soil C levels and residue retention, we measured organic C and ^{13}C natural abundance in soils under forest, and fertilized and unfertilized systems of continuous grass, and fertilized and unfertilized maize, in monoculture and legume-based rotations. Our data show that the soils under maize cropping had about 30–40% less C, and those under continuous grass had about 16% less C, than those under adjacent forest. Quantitative differences in net primary productivity and C inputs in the different agroecosystems did not account for observed differences in total soil C. The greatest differences observed in soil C levels between cropping systems were between rotation and monoculture maize systems (~20 Mg C/ha). Effects of fertilization on soil C were relatively small (~6 Mg C/ha), and differences were observed only in soils under monoculture maize. The amount of soil C derived from maize residues in fertilized monoculture soils was nearly two times greater than that in unfertilized monoculture. Soils under legume-based rotation accumulated the same amount of maize-derived C in fertilized and unfertilized systems. Retention of root C as soil organic matter was 4-5 times greater than the retention of residue C in the plow layer. We conclude that soils under legume-based rotation tend to be more "preservative" of residue C inputs, particularly from root inputs, than those under monoculture.

Best Management Practices:
None

Biosolids /Waste Application and Treatment:
Also see ECORC projects 36

21. Optimizing value-added products made from animal manures and sewage sludge for agricultural uses. H. Dinel, M. Schnitzer and T. Paré, ECORC-AAFC., soft-money.

The objective is to refine the development of organically-based fertilizers and growth substrates made from animal manures and sewage sludge and to validate their uses in agriculture. Preliminary greenhouse trials have shown that the organically-based fertilizers and growth substrates possess the essential characteristics to sustain the full development of plant.

22. Transforming organic residues (animal manures and sewage and papermill sludges) by biological and chemical processes into high-performance organically-based fertilizers and other chemical commodities.
H. Dinel, M. Schnitzer, T. Paré and M.-J. Tudoret, ECORC-AAFC., soft-money.

This project deals with the development of a conceptual design to produce high-performance NPK organic fertilizers and chemical commodities from agricultural and non-agricultural residues and to provide analytical data in support of engineering development, and to validate the

feasibility of the technology. The work achieved so far indicate that the proposed conceptual design will offer new avenues to pig and poultry producers by producing additional revenues.

23. Assessing the land application of raw and bio-stabilized organic residues on soil organic matter quality and bio-availability of trace elements.
H. Dinel, M. Schnitzer and T. Paré, ECORC-AAFC., A-base.

The objectives of this project is to assess the impact of adding raw and bio-stabilized organic residues on soil organic matter quality and on the bio-availability of trace elements. Collected data indicate that the addition of raw organic residues to agricultural soils increase the proportion of bio-available trace elements after only one year of application. On the other hand, when fully bio-stabilized organic matter from sewage sludge is used as growth substrate, tomato fruits contain between 40 to 50 % less trace elements.

24. Effects of organic matter addition on the bio-availability of trace metals originating from naturally-occurring minerals.
H. Dinel, M. Schnitzer, and T. Paré (ECORC_AAFC); R. Klassen (NRCan); and A. Jaouich and J. Lafrenière (Université du Québec à Montréal)., A-base.

In some regions of Ontario, the soil mineralogy is such that the minerals contained fairly large concentrations of trace elements (Hg, Cd, Cr, Ni, Ba, Mn). Agricultural practices are likely to release these trace elements from the mineral complexes. These trace elements will either be volatilized in the atmosphere (Hg), absorbed by plants or leached out of the soil profile to surface and subsurface waters. Laboratory incubation of the various soil layers of two profiles from the region of Thunder Bay, containing high levels of trace elements indicate that when soils are amended with raw organic matter, the availability of trace elements first decreases and then increases compared to the same soils receiving fully bio-stabilized organic matter.

Greenhouse Gas Emissions/ Climate Change:

Also see ECORC projects 20

25. Enhancement of Greenhouse Gas Sinks for Agroecosystems: No-till and C storage in eastern Canada E.G Gregorich, C. Topp, D. Lapen, (ECORC); C.F. Drury (GPCRC); D.A. Angers, Ste-Foy; M.R. Carter, Charlottetown. PERD 2000.

The goal of agricultural management practices is to maintain or increase soil carbon levels in order to maintain soil quality and also, possibly, to mitigate the rising level of atmospheric carbon. The objective of this study is to obtain preliminary estimates of carbon sequestration as a function of management practices for the main soil groups in Canada. Within this project a sub-study is being started this fall in Ontario that will evaluate the effects of plowing soils that have been under long-term (> 8 yr) notillage. Carbon in the soil profile and in different soil will be measured in notill soils before, and subsequent, to plowing.

26. Development of improved trace gas flux measuring systems and data management using relaxed eddy accumulation and eddy covariance techniques.
E. Pattey, A. Jones, D. Dow, M. Lefebvre, A. Saumure - AAFC, Ottawa, 1999.

The micrometeorological laboratory of AAFC developed measuring systems using eddy covariance and relaxed eddy accumulation (REA) techniques on tower-based platforms and on airborne platforms. The data acquisition and control system developed in-house for measuring trace gas fluxes using tower platforms in agricultural fields was recently improved by adding new features in the hardware and software. The new system includes a feedback loop for the position of the rotator, which allows the anemometer to be continuously oriented in the upwind direction, a more compact signal-conditioning unit, new filters for the input channels and the latest version of ECORC's existing acquisition and control software. Collaborative research between Peking University in China and ECORC is being carried out to evaluate the trace gas acquisition system.

27. Evaluating and improving the parameterization of biogeochemical processes associated with the flux of N_2O from Canadian agroecosystems.

R.L. Desjardins, E. Pattey, W. Smith, S. Kaharabata, C.R. Flechard, I.B. Strachan - AAFC, Ottawa, cooperation with I. MacPherson (NRC), 1999

The project involves modelling N_2O emissions and evaluating flux estimates at both field and regional scales. The distinctive features of this project are the focus on improving our understanding of processes associated with N_2O emissions from agroecosystems and the evaluation of model estimates of N_2O emissions at a regional scale in order to provide improved national estimates. The research combines the modelling efforts (DNDC, Expert-N) of several of the collaborators as well as the expertise to measure N_2O fluxes using towers, and the adaptation of the aircraft-based eddy accumulation technique to measure N_2O emissions on a regional scale. The data collection targeted the period during and after snowmelt, when significant N_2O emissions were observed by tower-based flux systems. Transect flights over contrasting areas in Eastern Ontario were carried out. Preliminary results indicated that larger N_2O fluxes were observed over agricultural areas as compared to forested areas. Nitrous oxide bursts were coincidental between tower- and aircraft-based observations.

28. Estimation of the potential for and the economic impacts of afforestation of cropland currently existing on poor quality soils in Canada.

T. Huffman, D. Kroetsch, M. McGovern, D. Lee, ECORC, Ottawa. 2000-2001.

Suggestions have been made that there exists a large potential in Canada for GHG emissions reduction and carbon sequestration by allowing and encouraging marginal farm operations to convert to tree production. In this project, GIS procedures are being used to assemble and analyse data relating to the extent, location, physical limitations and economic performance of farming on marginal land in Canada, to assess the capability for forestry of that land and to provide an assessment of the socioeconomic impacts on the farming industry of retiring from agricultural production land that has low capability for agriculture and some potential for forestry.

29. Crop yield and variability under climate change scenarios.

R. de Jong, K.Y. Li, A. Bootsma, T. Huffman, S. Gameda, ECORC, Ottawa. 1999-2001.

The rising trend of the global CO2 concentration is expected to induce a change in climate whose magnitude is still uncertain. General Circulation Models (GCMs) project a mean temperature increase in the range of 2 to 40 C in the agricultural region of Canada and estimates of changes in precipitation vary from -3% in southern Saskatchewan to approximately +8% in southwestern Ontario. The primary objective of this study is to evaluate, using the EPIC environmental simulation model, crop yields and crop yield variability under historic (1966-1995) conditions and under a climate change (2xCO2) scenario for 29 locations and soils across Canada.

Preliminary investigations have shown that the direct output from GCM's cannot be used as input to agricultural production modelling. Consequently, a 2xCO2 climate scenario was developed by combining 30 year historic temperature and precipitation data with the difference between 1xCO2 and 2xCO2 generated GCM data. Crop management files for two typical three year crop rotations, varying from one region to the next, contain fertilizer application data, tillage data and climate dependent planting and harvesting dates. The EPIC model was run to simulate barley yields at nine locations with local soils and fertilizer rates. Preliminary results indicate that 2xCO2 barley yields would remain near the same level as current ones in most agricultural regions of Canada, because positive (e.g. CO2 fertilization) and negative (e.g. increased water stress) effects of climate change would largely offset each other. The work is on-going for other crops and locations

30. Evaluation potential impacts of climate change on suitability/capability of Atlantic region to produce corn, soybeans and cereal crops by assessment of appropriate heat and moisture indices
(CCAF funded project, with principle investigators Andy Bootsma, and Sam Gameda, ECORC and D.W. McKenny, Canadian Forest Service, Sault Ste Marie).

The project involves developing algorithms and software to compute a suite of agroclimate indices from gridded monthly normals of temperature and precipitation. The indices include: Precipitation Deficit/Surplus, Effective Growing Degree-Days and Crop Heat Units. Procedures have been developed to efficiently extract climate change scenario results from the Canadian GCM and to prepare data for interpolation to a 10 km grid for the 2010-2039 and 2040 to 2069 periods. Data were interpolated using DEM data and a thin plate spline surface fitting technique. Monthly climate normals data for average daily maximum and minimum air temperature and total precipitation for the 1961-90 period were also interpolated to a grid. The data and software are being used to assess potential impacts of climate change on suitability/capability of Atlantic region to produce corn, soybeans and cereal crops.

31. Development of Climate Change Scenarios for the Agricultural Sector
S. Gameda, A. Bootsma, S. McGinn (Lethbridge), in collaboration with E. Barrow (Regina, Environment Canada) - AAFC Ottawa, 2000-2002.

Projected changes in greenhouse gas (GHG) concentrations are expected to result in significant climate change, with potentially substantial impacts on agriculture. These range from changes in growing season length, to increased climatic variability, potentially leading to dramatic changes to agricultural land suitability as well as crop development and yields. The data from Global circulation models (GCM) on future climatic outcomes typically are available at scales ranging

from 2.5 to 3.75 or coarser grids, and need to be downscaled to smaller grids (0.5 or finer) for use in sectoral scenarios. The needs for agricultural sector scenarios are for daily data of a number of variables (values and variances of Tmax, Tmin, precipitation, radiation), and therefore require both spatial and temporal downscaling of GCMs. Of a range of downscaling methodologies available for deriving detailed data from GCM outputs, statistical downscaling techniques offer suitable means of obtaining spatially and temporally detailed information. This project will downscale GCM data spatially and temporally to develop national scenarios at a 0.5 grid scale from the latest Canadian and UK (Hadley Centre) GCM experiments. The outcome of the project will provide a consistent set of scenarios for researchers modelling the impacts of climate change and variability on agriculture, and for evaluating the capacity of different agricultural management practices in achieving GHG mitigation and agricultural sustainability.

Integrated Pest Management:

32. Using IR imagery and airborne hyperspectral reflectance for early disease detection in crops.
B. Vigier, E. Pattey, I.B. Strachan – AAFC, cooperation with J. Miller (York U.), 1999

The project objective is to establish relationships between indices of canopy reflectance and the level of infection from fungal diseases in cereals and oilseeds. The study investigates the effect of white mold infection in soybeans caused by the sclerotinia sclerotiorum pathogen as detected by changes in reflectance measured by ground-based and airborne multispectral and hyperspectral remote sensing. To date, there is evidence to suggest differences between infected and control plots and analyses are underway comparing the spatial patterns of reflectance using geostatistical methods and geographic information systems (GIS) mapping techniques. This study will provide new knowledge in disease epidemiology and disease dispersal and also help to establish ground truthing algorithms that could be used on a large scale using satellite imagery.

Agroclimate

33. Development of improved autostation data management and implementation of new technology to provide improved real-time Internet access to the Ottawa CDA autostation.
(H. Hayhoe, A. Jones and D. Balchin - ECORC

Systems are currently available to retrieve hourly weather data from an autostation and to store them in a database. Traditionally we required someone to update the data on the Internet. We are working on software to make preliminary quality checks of the data and to automatically update the data on our Web page on an hourly basis. Users will have the option of displaying the real time data in tabular or graphical form.

We are conducting trials of the precipitation gauge for collecting solid and liquid precipitation which was developed through a collaborative agreement with Presentey Engineering.
The plan is to document the results of the trials and prepare documentation to assist in finding a private company with the resources to produce and market the gauge.

34. Evaluation weather and soil factor contributing to winter survival of winter wheat on a low lying plot on the Central Experimental Farm, Ottawa
(H. Hayhoe, C. Andrews, D. Lapen, ECORC

We have now accumulated 7 years of data on soil temperature, snow depth, soil moisture and winter wheat survival on a low lying plot on the CEF, Ottawa. Elevation was measured on the plot as well as the extent and duration of ice sheets. The temperature-based winter survival model incorporated in the CERES yield model is being used to assess the extent to which cold soil temperatures explain spatial differences in survival. Preliminary analysis has indicate that elevation is an important variable in explaining spatial variation in winter survival. We are applying statistical and modelling techniques to analyse the relationship between weather and winter survival and to develop a predictive relationship.

Ontario Land Resource Activities:

Also see ECORC projects 7-9, 14, 16

35. Development of a Regional Environmental Information System for Eastern Ontario.
I. Jarvis. AAFC, ECORC. 1999-2002

The data, data management and analytical capabilities of many rural municipalities are inadequate for regional resource management. A county level environmental information system is necessary to support proactive planning tools to address these issues and move towards sustainable rural development. The Objective of the REIS project is to develop a regional environmental information system to guide rural development and sustainable agriculture in Eastern Ontario. The REIS provides a regional context and information base for proactive decision-making, and will improve the capacity for resource management on a cost-effective basis.Key phases in system development include:
1. system design and standards development; 2. data catalogue, database and metadata assembly; 3. analytical tool development; and, 4. web based knowledge access tools.
Principal collaborators include: The United Counties of Stormont, Dundas and Glengarry; The United Counties of Prescott and Russell; The United Counties of Leeds and Grenville; and The Regional Municipality of Ottawa-Carleton. Through involvement with the Eastern Ontario Water Resource Management Study there has also been significant support and direction for the REIS from: Ontario Ministry of Agriculture, Food and Rural Affairs; Ontario Ministry of Environment; Raisin Region Conservation Authority; South Nation Conservation, and a comprehensive list of Eastern Ontario producer and commodity groups.

36. Assessment of Inherent Nutrient Capacity, Nutrient Balance and Land Use Planning Constraints on Agricultural Intensification/Expansion in the United County's of Prescott and Russell.
I Jarvis, AAFC, ECORC, and G. McTavish, OMAFRA. 2000-2002.

As population pressures increase, and as the number of farms and area of farmland continues to decline, agricultural production is intensifying to meet the increased demands of the growing population while maximizing economic return. The net result of these trends suggests that:

a. while the need for agricultural production will continue to increase, the area available for agricultural intensification and/or expansion is decreasing as other uses increase; and
b. the remaining land base has finite potential to cycle nutrients within safe and acceptable guidelines.

The overall objective of this research is to investigate the inherent capacity of the landscape to assimilate organic and inorganic nutrients, create a nutrient balance using current land allocations, and to balance this analysis with an assessment of the constraints imposed on agricultural expansion/intensification by present provincial and municipal land use policy and legislation. Collaborators in this project include the Prescott Federation of Agriculture, the Ontario Federation of Agriculture, and the Ontario Ministry of Agriculture, Food and Rural Affairs.

37. Development and Application of a GIS Based Land Evaluation and Area Review System For the United County's of Stormont, Dundas & Glengarry.

I. Jarvis, AAFC, ECORC and G. McTavish, OMAFRA, 2000-2001.

The conversion of agricultural land to non-farm uses has a significant impact on the quantity and quality of land available for agriculture. Unabated this decline may have a detrimental impact on the long term sustainability of agriculture in heavily populated regions, such as Southern Ontario. The objective of this research is to evaluate the quality of resource lands by applying Geographic Information System (GIS) technology to integrate soil related biophysical capability with socio-economic factors, using the province's Land Evaluation and Area Review (LEAR) system. Factors are weighted based on community input to come up with an overall evaluation that is unique and reflects community values. Once complete the evaluations are used by the municipalities to create official plan designations that restrict non-farm development and protect the resource. Project collaborators include the United Counties of Stormont, Dundas and Glengarry; and the Ontario Ministry of Agriculture, Food and Rural Affairs.

38. Re-survey techniques and methodology development and re-survey of the Municipality Mississippi Mills, Lanark County, Ontario

D. Kroetsch, AAFC, ECORC and G. McTavish, OMAFRA, 2000-2002.

In recent years ECORC has been conducting research into the development of cost effective soil survey upgrade techniques. These techniques use current information and technology to improve the quality of land resource information to present day standards for land use planning. During this research it has been noted that some areas have either changed since, or were inconsistently inventoried during the original survey. In these instances the upgrade techniques are not sufficient to bring the survey up to standard. The objective of this research is to develop re-survey techniques which are more intensive than upgrades, but much less intensive than an original survey. The research will examine the use of new geospatial techniques to develop and evaluate methodologies to evaluate and improve existing soil polygon boundaries in the study area. Techniques include using high resolution remotely sensed imagery, digital surficial geological information and digital elevation models in conjunction with Geographic Information System (GIS) spatial analysis techniques. Collaborators in this project include the Township of Mississippi Mills and the Ontario Ministry of Agriculture, Food and Rural Affairs.

39. Prince Edward County Climatic, Soil and Landscape Assessment for Specialty Crop Production.

I. Jarvis, H. Hayhoe, AAFC, ECORC, R. Valitis and E. Wilson, OMAFRA.2000-2003.

The wine industry in Prince Edward County is in the initial stages of development. Vineyard acreage more than doubled during 2000. The potential of the county is generally attributed to its unique climate, soils and topography. However, the specific extent of the potential is largely unknown because the information available to assess suitability for grape production does not exist at an appropriate scale or level of accuracy. The lack of appropriate information has resulted in difficulty for growers to identify potential sites to farm, and stands in the way of VQA recognition. The limited information also makes it difficult for county land use planners to identify lands which should be protected from non-farm development since the existing Canada Land Inventory mapping does not address specialty crop production. The objective of this project is to upgrade the state of land and climate information, meet the VQA guidelines for identifying geographical features of a viticultural region, and to develop a new approach to County scale suitability assessment for specialty crop (grape) production. The research will result in new soil, terrain, climate and land use assessments which will be integrated to produce an overall assessment of vineyard suitability. Project collaborators include the Prince Edward County Wine Growers Association; Prince Edward County; and the Ontario Ministry of Agriculture, Food and Rural Affairs.

National Land Resource Activities

Also see ECORC projects 8, 16, 28, 31

40. National Soil Databases and Geoconnections.

P. Schut, D. Pagurek, A. Villeneuve

Geoconnections is a federal program which encourages the use of geographic information on the Internet. ECORC staff represent AAFC on several key Geoconnections committees, including both Framework Data and Access, to ensure that the requirements for agricultural and environmental databases are accommodated in the Canadian Geospatial Data Infrastructure (CGDI). The Soil Landscapes of Canada (SLC) is AAFC's national land resource database, and it has been adopted as one of several CGDI Framework datasets. Geoconnections is funding the migration of the SLC to the new national base, to ensure that information in the SLC can easily be used in conjunction with other environmental and economic datasets of national importance. In the future, ECORC staff will partner with the Geoconnections program to facilitate the use of and access to the SLC.

41. National Pedon Database

(C.Tanocai, I. Jarvis, P. Schut, S. Smith, G. Coen, G. Padbury, H. Veldhuis, J-M. Cossette, H. Rees and K. Webb)

This database was developed this year to store morphological, chemical and physical data for representative pedons for each named soil. The data in the database, which is in Oracle format, can then be used for a variety of agricultural interpretations and modeling.

42. Network for Research on Information Technology for Land Management

S. Gameda, T. Huffman, in collaboration with Z. Mikolajuk (Singapore, IDRC) and F. Penning de Vries (Bangkok, Thailand, IBSRAM) - AAFC Ottawa, 1999-2001.
The availability and usability of application software to support research as well as land management processes needs broad interdisciplinary collaboration and effective means for exchange of information on new software development tools and applications. This project supports creation and operation of an international network of individuals and institutions that are interested in information technology for land management and deployment of applications in organizations and government structures. Project activities include development of a strategy for land management support, collection and dissemination of information on relevant projects, survey and evaluation of application software, experimentation with new software development tools, electronic discussions, virtual working groups, and face-to-face workshops. The network plays a complementary role to research and land management activities of its members.

Tillage Energy

43. Effect of organic amendments on tillage energy

N.B. McLaughlin, E.G. Gregorich, L.M. Dwyer, B.L. Ma, G.C. Topp (ECORC, Ottawa)
J.A. MacLeod, B.L. Sanderson, M.R. Carter and V. Rodd (Charlottetown Research Station, Charlottetown, PEI)

Tillage energy measurements were in existing research plots to study manure use in corn production in Ottawa (see ECORC project #1), and manure and compost use in a potato rotation in Charlottetown, PEI. AAFC's instrumented research tractor was used for fall mouldboard plowing, and both fuel consumption and implement draft measurements were made. Preliminary data analysis indicates that the plots in Ottawa receiving high rates of manure had lower fuel consumption and implement draft for the plowing operation. Data from the PEI plots have not yet been analyzed. The lower tillage energy for the high manure rates was attributed to an improvement in soil structure resulting from an increase in soil organic matter.

44. Mapping tillage energy

N.B. McLaughlin (ECORC, Ottawa)

Methodology was developed for producing spatial maps of tillage energy similar to the familiar combine yield maps. A GPS was added to AAFC's instrumented research tractor allowing each measurement of implement draft and fuel consumption to be tagged with spatial coordinates. Spatial maps of tillage energy were made for normal spring and fall tillage operations in a 35 ha field near Ottawa (see ECORC project # 13). The maps showed consistent patterns in the field over time, and for different tillage implements. These spatial patterns are related to spatial patterns in soil physical attributes. Further study is needed to delineate these relationships, and to determine the usefulness of tillage energy maps in management decisions in site specific agriculture.

Land Resource Research Priorities

Over the past 80 years soils of the entire agricultural portion of Southern Ontario has been surveyed at least once. Over the course of soil survey the mapping concepts, applications, and the soils themselves have changed. As a result of the changes many surveys are not consistent in format, content and accuracy. The level of inconsistency is generally a function of soil survey age, landscape and land management factors such as slope and tillage history. Consequently there is an overarching need to maintain soil resource knowledge as embodied in soil databases, regional pedologic expertise and a requirement to upgrade information so that it is consistent, accurate and meets current needs for resource management decision support.

Virtually every aspect of environmental resource management requires knowledge of the land resource. When available, digital soil surveys provide the most appropriate spatial framework for scaling plot/field research to scales which are relevant for developing and monitoring land use policy and legislation.There is also a need for the development of applications of land resource data to address questions of economic and environmentally sustainable development in Ontario.

The following research recommendations address the needs for: 1, maintaining and updating the knowledge of land resources, and 2, the application of land resource information to address the resource management issues of the day. The priorities are placed in order of relative importance with the highest priority in each category listed first.

A. Research Priorities to Develop and Maintain the Knowledge Land Resources in Ontario

1. Soil survey upgrade and re-survey techniques. Since the original soil surveys, data and information technology have improved considerably. For example, many of the original surveys were made without air photo's. Now remote sensing and three dimensional terrain models are available. The applications of soil survey information has also changed over time, and the need for consistent, correlated soils mapping at 1:50,000 scale is now a widely accepted standard for municipal land use planning. There is a need for research to develop cost effective soil survey upgrade techniques which incorporate new information to improve land resource data to current standards.

2. Characterize the location and extent of soil landscape change. Field observations have indicated that irreversible changes in soil characteristics have occurred over extensive agricultural areas of Ontario since the original soil surveys were developed. These observations suggest that current soil conditions are less resilient than during the time of original survey and the changes in soils have a significant impact on the inherent productivity and sensitivity to environmental impact. These observations lead to the conclusion that many soil surveys are no longer representative of actual soil conditions. However, the extent of these areas are currently an unknown. Research is required to determine the extent and location of change in order to identify areas where published soil survey data may no longer be representative of actual conditions and soil survey upgrade is required. These research results should form the basis for the prioritization of soil survey revision and upgrade activities in the province.

3. Landscape characterization. The application of land resource information to address resource management issues such as nutrient management and soil erosion requires accurate landscape

information such as slope, slope length and aspect. With remote sensing technology and the development of digital terrain models, the data available to characterize landscape is much improved over the original landscape information incorporated in soil surveys. Research is required to develop better characterizations of landscape and integrate this information with digital soil surveys.

B. Research Priorities for the Application of Land Resource Information to Resource Management Decision Support

1. Scaling-up farm and plot research. Research is required to develop better tools, techniques and error assessment for the scaling of site specific research to scales relevant for land use planning. Research is also required to examine the integration of land resource information with other bio-physical and socio-economic data to create resource management models and decision support for land use planning. Applications should include: nutrient capacity/management; land suitability assessment; risk of impact on land, water and air resources; regional greenhouse gas and carbon sequestration models.

2. Impact assessment of policy and regulation. Land use policies have a measurable impact on the location and nature of agricultural activities. As an example, the impact of livestock facility sighting set back policies can be spatially expressed to characterize the potential impact on the distribution of agricultural activities in a region. Research is required to develop assessments of the impact of current and proposed policies on the distribution of agricultural activities.

The Land and Agronomy Section

The **Land and Agronomy Section** consist of 8 study areas and maintains the National Soil Data Base:

Soil Carbon and Nitrogen Management:

Evaluates management practices that optimize soil microbial, carbon and nitrogen resources for sustainable production of corn, wheat and soybean.

Soil Environment:

Optimizes the soil management practices for improved crop performance and soil health by monitoring and taking into account weather, differing types of tillage and crop rotations for corn, wheat and soybean.

Physiological Limitations to Production:

Identifies physiological limitations to grain and silage corn production under low input production systems and recommends crop management practices for Eastern Canada.

Precision Farming:

Assesses methods of measuring spatial variability of soil and crop attributes within a field, their contribution to crop production and potential as indicators of crop yield.

Agroclimatic Resource Assessment in a Changing Climate:
Develop methodologies and carry out agroclimatic resources assessments for current and forecast climate scenarios to identify impacts, opportunities and adaptation strategies.

Regional Land Resource
Provide information, expert knowledge in pedoloy, and interpretations and integrations of soil data with other resource and socio-economic data, to support improved allocation and sustainable use of land resources in eastern Canada.

Land Quality Modelling:
Develops methodologies to integrate biophysical conditions, socioeconomic forces and production systems to assess the risk of environmental degradation and provide decision support systems for policy makers. Includes procedures for assessing landscape variability

Soil Taxonomy and Databases:
Develops, manages and applies a comprehensive and integrated national database of soil, climate, land use, crop yield and socioeconomic information of importance to agriculture and other Canadian industries; and carries out research relating to soil taxonomy.

Resources
ECORC is the custodian of the National Soil Data Base. The unit responsible for this database, named the **Canadian Soil Information System (CanSIS)**, works with specialists in all Canadian provinces and develops tools for storing, retrieving, transforming and displaying spatially referenced data. CanSIS has national responsibility to develop, manage and integrate the National Soil Data Base with climate, land use, crop yield and socioeconomic information of importance to agriculture.

Studies and Team Members
Section Head
Sherman Nelson, PhD.
Tel: 613-759-1901, Fax: 613-759-1926
E-mail: nelsonsd@em.agr.ca

Soil Carbon and Nitrogen Management:
Ed Gregorich, PhD. Study Leader, Soil carbon and nitrogen chemistry
Sherman Nelson, PhD. Mycorrhizal/Soil/Plant interactions

Soil Environment:
Clarke Topp, PhD. Study Leader, Soil physics;
Supervisor of mechanical and electronics shop

Physiological Limitations to Production:
Baoluo Ma, PhD. Study Leader, Crop physiology;
Supervisor for centralized lab
Doug Stewart, PhD. Crop modeller

Precision Farming:
Neil McLaughlin, PhD., Study Leader, Agricultural engineering
Elizabeth Pattey, PhD., Micrometeorlogy
Bernard Vigier, PhD., Agronomy and plant pathometry

Agroclimatic Resource Assessment in a Changing Climate:
Henry Hayhoe, PhD.Study Leader, Biomathematics
Andy Bootsma, MSc. Agrometeorology
Reinder DeJong, PhD, Soil water modelling

Regional Land Resource
Ian Jarvis, MA, Study Leader, Land resource data applications
David Kroetsch, BSc, Land resource data applications

Land Quality Modelling:
Ted Huffman, PhD., Study Leader, Land use and remote sensing,
Henri Dinel, PhD., Soil biochemistry
Sam Gameda, PhD., Expert systems

Soil Taxonomy and Databases:
Charles Tarnocai, MSc. Study Leader, Soil genesis, classification, and databases
Peter Schut, MSc. Information systems, GIS
Peter Brimacombe, BSc., Management of computer resource (ArcInfo and Unix)

Field Crops, Soil and Environmental Quality Team
Southern Crop Protection and Food Research Centre
Research Facilities in London, Delhi, Vineland

Team Members

Dr. Bonnie Ball-Coelho	Soils and crop production
Dr. Ron Beyaert	Soil quality
Dr. Jim Brandle	Plant biotechnology
Dr. Bruce Broadbent	Entomology, biocontrol
Dr. Ralph Chapman	Chemistry
Dr. George Lazarovits	Plant pathology
Dr. Brian McGarvey	Chemistry
Dr. John Potter	Nematology
Dr. Rick Reeleder	Plant pathology
Mr. Bob Roy	Agronomy
Dr. Jeff Tolman	Entomology
Dr. Ed Topp (Team leader)	Soil microbiology
Dr. Jim Traquair	Mycology

Research of the Field Crop, Soil and Environmental Quality Team at SCPFRC emphasizes contaminant fate, soil quality, and the development of farming systems which minimize environmental risk. The overall goal is to improve soil and environmental quality in the Great Lakes Basin by developing superior management practices that preserve and enhance land resources while maintaining economic benefits to society and minimizing risk to adjacent environments. Team members, subgoals, activities and publications can be vieved on our web site at **http://res.agr.ca/lond/pmrc/pmrchome.html**

Soil Quality

1. Cropping and tillage systems to enhance soil carbon sequestration. R. Beyaert, R.Reeleder (SCPFRC); R.P. Voroney (U. of Guelph)

Greenhouse gas emissions and climate change are important issues to agriculture both because of their potential impacts on agricultural production and because agriculture is a contributor to the build-up of greenhouse gases in the atmosphere. Soil organic carbon levels are determined by the balance of inputs, such as crop residues and organic amendments, and carbon losses through organic matter losses. Thus, management of agricultural soils to sequester carbon required increasing inputs, decreasing decomposition or both. To investigate the effects of cropping and tillage practices, plots were established in 1989-1990 with three cropping systems, Continuous Corn, Soybean-Wheat and Tobacco-Rye systems each managed under conventional and no-

tillage. Sampling following the 12th year of management and 10th year of decomposition study will be completed during the 2000/2001 fiscal year.

2.Impact of vegetable production practices on soil processes. J. Tolman, R. Chapman (SCPFRC); C. Fox (GPCRC).

Two long-term experiments evaluating effects of vegetable production practice on soil process continued in "maintenance mode" in 1999. Production practices were maintained but the number of vegetables and amount of field sampling reduced. After 10 years, soil organic matter has increased 48.6% in ORGANIC plots and decreased 5.4% in companion CONVENTIONAL plots. After 9 years, soil organic matter in plots in CONTINUOUS production of sweet corn or tomatoes has fallen an average of 2.7%. Yields of sweet corn and tomato in 1999 were lower in ORGANIC plots than in CONVENTIONAL plots; production practice had no significant impact on yield of snap bean. While sweet corn yields have remained relatively constant under CONTINUOUS production, relative tomato yields have declined by over 50% and are lower than yields in ORGANIC plots. Final results for the very wet 2000 season are not yet available.

3. Method development for evaluating impacts of GMOs on soil biology. E. Topp, R. Beyaert, J. Brandle, G. Lazarovits, J. Potter, R. Reeleder, J. Tolman, J. Traquair (SCPFRC); C. Fox (GPCRC).

It is highly likely that plants which have traits introduced using biotechnology are going to dominate crop production in the future. Input traits which protect crops against pathogens and reduce pesticide use have the potential to improve crop quality and reduce environmental pollution by pesticides. Output traits consisting of vaccines, antibodies, and other proteins will add tremendous value to crops. The major barrier to implementation of this technology has been public concern about the possible risks of these crops to environmental and human health. Furthermore, regulators are now faced with assessing the real risk of transgenic crops to the environment using the best available science. Part of this risk assessment concerns the possible deleterious effects of GMO crops on agricultural soils, and the fate of transgene products in soils. There is a real need to conduct research on developing methods to assess the risks of transgene crops. The primary focus of this study is the assessment of transgene crop impact on agricultural soil biology (bacteria, fungi, mites, springtails, earthworms, surface-active beetles) and functions (carbon and nitrogen dynamics), and the persistence of transgene protein products in soils.

4. Control of soilborne pests by application of livestock wastes and other organic amendments. G. Lazarovits (SCPFRC); Ontario Potato Marketing Board, Rothsay Inc., Ontario Pork, Canadian Adaptation Council, Nuhn Indsutries, Fats and Proteins Foundation (USA).

Potato growers have been reluctant to use manures because of the fear of increasing the incidence of soilborne plant diseases. The objective of this project is to determine the impact of manures on such diseases of potato (*Verticillium* wilt caused by *V. dahliae*, potato scab caused by *Streptomyces* spp., and root lesions caused by nematodes). We have shown that manures can significantly reduce populations of these pathogens in soils under certain conditions. The potential efficacy was dependent on the source of the manure, the soil type, and the moisture

content of the soil. Some laboratory results have shown that certain manure-soil mixtures can increase populations of *Streptomyces* which may translate to higher disease incidence. We are investigating this further. A rapid laboratory assay was developed that accurately predicts how a manure will affect populations of these pathogens in a particular soil. The accuracy of this test was confirmed by carrying out parallel laboratory and field experiments. This should provide technology whereby growers can pretest specific manures prior to application to determine the impact on plant pathogens. The disease protection has been extended over a two year period and that with some manures, particularly poultry, there was a significant yield increase in the second year, but not in the first, likely because of some residual phytotoxicity.

5. Mitigation of contaminant tranfer to the environment from fertilizer and manure by cover cropping, soil testing and appropriate rates and methods of application.
B. R. Ball Coelho, R. C. Roy (SCPFRC); Long Point Region Conservation Authority, Nuhn Industries, Precision GPS, Van Raay Farms, Da Costa Farms, Kevin Otto, Ontario Pork, Don Hilborn (OMAFRA), A & L Laboratories, London.

In systems where N is supplied by inorganic fertilizer, residual N not taken up by a corn crop can be recycled and nitrate movement to groundwater reduced by overseeding cereal rye into standing corn. Over the long-term, cover crop growth has correlated positively with residual nitrogen (ie more growth after dry growing seasons), and yield gains with cover cropping increased with time. Farm demonstrations confirmed that aircraft is a practical method for seeding the cover crop. Capacity of the overseeding system to control nitrate leaching in manured systems is currently under investigation. Preliminary results indicate that nitrate leaching is similarly reduced by the cover crop in systems where N is supplied by liquid hog manure.
Transfer of nutrients to ground and surface waters following manure application can also be minimized and crop nutrient utilization maximized by appropriate methods, timing and rates of application. Optimum timing for manure application to corn may be sidedressing because soil moisture content is usually lower and application rates can be determined more accurately than for fall or spring applications. In order to improve the prediction of manure sidedress rates based on the pre-sidedress nitrate test (PSNT), corn yield response curves to sidedress liquid manure injection in relation to the PSNT, transfer of contaminants to drainage waters, and residual soil N will be determined. Where different rates of liquid hog manure were injected and top-dressed in narrow-row, no-till corn, yields were not altered by method of application and the PSNT correctly indicated whether additional N was required in 80% of cases.

In sandy soils, contaminant movement following manure application has been studied less than in tiled systems, although numbers of intensive livestock units are increasing in areas where land is not systematically tiled. Many livestock producers have rejected or abandoned no-till or conservation tillage systems due to difficulties associated with manure injection. Injection solves application-related odour problems, maximizes nutrient use efficiency and reduces movement of contaminants to surface waters. No-till injection technology, however, has not been refined. Optimal injection units will likely vary with soil texture and cropping system. Nutrient movement to groundwater is monitored following pre-plant injection for no-till corn in sandy soil. Preliminary results indicate that where liquid hog manure is pre-plant injected to supply

corn N requirements, nitrate leaching is no greater than where N is supplied by inorganic fertilizer.

Water Quality

6. Environmental persistence and impacts of endocrine-disrupting chemicals and antibiotics. E. Topp, (SCPFRC); M. Servos (Environment Canada); T. Ternes (ESWE, Germany); S. McEwen (U. of Guelph); Toxic Substances Research Initiative.

Agriculture is accused of being a source of chemicals which interfere with the reproduction and development of wildlife. These so-called endocrine disrupting chemicals cause fish to produce offspring which are part male and part female, for example. Chemicals of concern include some pesticides and components of pesticide formulations, natural estrogenic hormones in some animal wastes, and synthetic organic compounds which can be carried by municipal biosolids applied to land. The persistence and breakdown of various natural (estradiol, estrone) and synthetic (ethynylestradiol, 4-nonylphenol) EDCs is being evaluated in field and laboratory studies. Laboratory microcosm studies indicate that all of these compounds are rapidly microbially degraded without production of estrogenic intermediates.

There have been recent concerns about the environmental impact of veterinary antibiotics, or antibiotic-resistant bacteria excreted by animals. We are conducting laboratory experiments examining the impacts of antibiotics on soil processes, and on the abundance of antibiotic-resistant bacteria. We are also evaluating soils fertilized with manure from medicated and non-medicated animals for differences in the abundance of antibiotic-resistant bacteria. Transport of antibiotics through intact lysimeters is being evaluated by German cooperators.

7. Nitrates leaching from composts used to control soil-borne pests in ginseng production. R. Reeleder, B. Ball Coelho, R. C. Roy (SCPFRC); Ginseng Growers Association of Canada.

Laboratory screening has shown that CUMIX (60:30:10; mushroom / yard waste / pine bark compost) amended soil suppresses *Cylindrocarpon* and *Phytophthora*, two soilborne pathogens which cause root rots in ginseng (*Panax quinquefolius*). Therefore field trials were initiated to evaluate agronomic suitability and effectiveness of the mix for disease suppression. Prior to bed-making in October, three rates of compost mix were incorporated : 0 (control); 200 Mg ha^{-1}; and 170 Mg ha^{-1}. Straw, pine bark, and 90 Mg ha^{-1} of compost mix, were applied as mulch layers to the 0 (C_0), 200 (C_{200}) and 170 (C_{260}) Mg ha^{-1} treatments, respectively after seeding. Populations of pathogens, nutrient concentrations and plant disease ratings are being monitored on an on-going basis to determine the effects of compost additions on nutrient dynamics and disease control. Nitrate movement to groundwater has been monitored using solution samplers with ceramic cups positioned below the 1 m depth.

8. Stimulation of pesticide-degrading microorganisms in soil. E. Topp (SCPFRC); S. Houot (INRA); W. Mulbry (USDA).

The persistence of pesticides in soil is largely determined by microorganisms that have the ability to degrade these chemicals. Ideally, soil-applied pesticides persist the minimum time

required to ensure efficacy but minimize the chance of off-site movement. Bacteria that degrade atrazine were found to increase with the frequency of soil application of this commercially important herbicide used in corn production. Manuring soil also increased their abundance. Isolated bacteria are being characterized with respect to the genetics and biochemistry of herbicide biodegradation. This information is being used to explore and predict how bacteria adapt to the introduction of xenobiotics into soil, and how their activity may be stimulated through the addition of organic amendments.

9. Enhancement of water use efficiency for crop production. B. Ball Coelho, R. C. Roy, R. Beyaert (SCPFRC); Roberts Irrigation Products, Inc., Plastitech, Netafim Irrigation, Inc., Vanden Bussche Irrigation & Equipment Ltd.

Surface and subsurface drip irrigation increases water use efficiency by minimizing losses to evaporation, improving scheduling and increasing the capacity for control of internal drainage. Subsurface fertigation further provides opportunities to utilize nutrients more efficiently and improve water quality through better timing of application and placement of nutrients, and minimal water losses by deep percolation and erosion. Many advances in subsurface drip irrigation have been made in recent years, however, most of the work has been done in loam soils and little is known about how these systems behave under Ontario climatic conditions and coarse-textured soils. To determine the optimum configuration for drip irrigation, radial and vertical movement of water + tracer from emitters placed on the surface or buried at 2 different depths on flat surfaces or beds at different flow rates was measured. Subsequent experiments will involve development of a sensor-based drip irrigation schedule; comparisons of water use efficiencies and nitrate leaching of sprinkler, surface drip and sub-surface drip irrigation; and comparisons of traditional dry broadcast fertilization with fertigation.

10. Calibration and validation of nitrate leaching prediction models. B Ball Coelho (SCPFRC); George Rogers.

Coarse-textured soils are so susceptible to N leaching that crop N deficiencies can arise following heavy rains. Under- or over-application of N fertilizer by growers (particularly on horticultural crops) in response to estimated losses could be avoided by modelling N leaching. Models developed to predict N losses must be calibrated and validated for regional or local systems. Rainfall simulators are used to impose leaching events on field plots (not at steady state) which are instrumented to monitor movement of water, and nitrogen and bromide from soil and banded fertilizer. Bromide is added to fertilizer as a tracer to distinguish between movement of nitrate from soil vs fertilizer. Some of the variables tested are rainfall intensity, fertilizer rate and soil texture. These data are being used to calibrate and validate LEACHW and LEACHN. Once validated, the models could be simplified for use at the extension or grower level. This would improve the accuracy of fertilizer rate recommendations and help to reduce nitrate movement to groundwater.

11. Ecology of *Escherichia coli* and other microbial components of livestock waste in soils and stored manures. E. Topp, G. Lazarovits, B. Ball Coelho (SCPFRC); Ontario Pork, Nuhn Industries.

Enterohemorrhagic *Escherichia coli* is the most important recently emerged group of food-borne pathogens. Human and livestock exposure to fecal pathogens via contaminated surface or groundwater is an important health concern. There have been frequent recent high profile closings of beaches due to coliform contamination, suspected but not proven to originate from livestock operations. Survival of fecal bacteria in soil and on crop surfaces is an important element of the environmental and health risks of manure application. The focus of this study will be to characterize the microbial composition and survival of enteric bacteria and pathogenicity genes, and antibiotic-resistant bacteria in manure under different storage conditions, and in soil following broadcast or injection application.

Research Efforts within Ontario Conservation Authorities

Ted Briggs, UTRCA

There are 38 Conservation Authorities within the province of Ontario. These community-based environmental organizations work at conserving, restoring, developing and managing natural resources on a watershed basis.

Some of the main objectives of the Authorities is,

to ensure that Ontario's rivers, lakes and streams are properly safeguarded, managed and restored

to protect, manage and restore Ontario's woodlands, wetlands and natural habitat;

to develop and maintain programs that will protect life and property from natural hazards such as flooding and erosion;

to provide opportunities for the public to enjoy, learn from and respect Ontario's natural environment.

Conservation Authority's have also been involved in a number of research and environmental monitoring impact studies both on their own or partnered with various agencies, academic institutions, municipalities and community groups. The following provides a brief outline of some of the efforts that are being undertaken by some of the Conservation Authorities across the province. It should be noted that not all studies and research work being done by CA's is outlined in this summary, however it is hoped that this will provide the reader with some idea of some of the work that Authorities are involved in.

I) Agricultural Related Research in the Upper Thames River Conservation Authority Watershed

Manure Research (1988-present): Work with Agriculture Canada , OMAFRA on a manure spreading to monitor flow pathways through soil to tiles and to develop precision manure application equipment to maximize nutrient availability and minimize environmental impacts. Also worked with Agriculture Canada to examine movement of manure nutrients through soil profile and to deeper groundwater under precision manure application systems.

Winter Spreading Study (1992): Work with Ministry of Environment to understand fate of manure bacteria during winter manure spreading.

Waterloo Study (1994-97): Worked with University of Waterloo to monitor flow of manure nutrients through the soil profile to tiles and to deeper groundwater.

Artificial Wetland Treatment Systems for manure runoff - experimental constructed wetland systems were constructed by a number of Authorities during the 1990's. The design of these systems mimics that of a natural wetland, natures method of holding and purifying surface water. The systems varied somewhat in design however most consisted of a three stages which included a settling basin, vegetated marsh and pond. Water quality treatment of the runoff water has been found to be very good with contaminant reductions in some cases of well over 90%. Although the treatment ability of agricultural constructed wetlands looks promising, several factors still need to be determined including: a) practical methods for handling excess treated water, b) regulations/permits required c) longterm maintenance needs.

Table Summarizing UTRCA Special Studies

Project Name	Description/Purpose	Date/Status	Partners	Comments
Southwest CA's Drain Classification	Classify municipal drains for habitat type. Collects species occurrence for top level drains	Initiated in 1999 Should be completed for all of sw Ont by end of 2000	All SW Conservation Authorities (13 offices) Department of Fisheries and Oceans, MNR, HRDC	Covers the area from Niagara and Grand Watersheds, up to Grey Sauble and all CA's west
Middlesex Natural Heritage Study	Assessment of natural heritage areas in Middlesex County and establish criteria for significance.	Preliminary work completed. Main project component approved by County and other funding partners. Completion 2002	Middlesex CA's MNR Carolinian Canada Middlesex Stewardship Council County of Middlesex	
Oxford County Terrestrial Ecosystem Study		develop strategy for Dorchester Swamp involving local landowners.	Completed 1997.	Carolinian Canada
Kintore Creek Paired Watershed Study	paired watershed study comparing traditional and conservation tillage practices.	1981-1998	MOE, Environment Canada, Ag Canada, OMAFRA,U of G, U of W.	a number of smaller studies carried out in Kintore with respect to nutrient movement in soil.
Fanshawe Lake Bubble Project	A project to test the use of a bubble line/aeration system to improve water quality and prevent algae blooms as well as diffuse waves for rowing competitions	In 1999 a pilot system was tested and in 2000 this same system is being re-installed for further tests. If system is successful will work towards a full-scale system in 2001	University of Western Ontario, Thames River Anglers Assn, UTRCA, Compressor Engineering Group, Rowing Clubs	

Project Name	Description/Purpose	Date/Status	Partners	Comments
UTRCA Conservation Strategy	A project to develop targets for conservation measures in the 28 subwatersheds within the Upper Thames River watershed	The process was initiated in 1999. A model for water quality and forest health was developed to rank each subwatershed. Watershed report cards are scheduled for completion the end of 2000	UTRCA, peer review by individuals at a number of agencies/organizations	
Wildwood Lake Aeration	A project to improve low oxygen in water immediately downstream of Wildwood dam	A scale model for a submerged fountain is being tested at the UWO engineering dept.. If successful a full scale unit will be installed on the outflow pipe of the dam	University of Western Ontario, UTRCA	This project is to address fish kills which have occurred as a result of low oxygen downstream of the dam
Zebra Mussel Study	A study which compares the growth of native clams in a lake dominated with zebra mussels (Lake St. Clair) with survival in a lake without zebra mussels (Fanshawe)	The monitoring station was installed in August 1999 and the study will be complete in 2000	University of Guelph, UTRCA	

II) Phosphorus Management Strategy in the South Nation River Watershed

There is a new approach to phosphorus management for municipal and industrial wastewater discharges in the South Nation Watershed in Eastern Ontario. Total Phosphorus Management (TPM) allows dischargers to offset increased phosphorus loads by implementing non-point source projects elsewhere in the watershed. TPM is good for water quality and the environment, and is cost-effective for municipalities and industries.

The Ontario Ministry of Environment approved this innovative water management strategy for phosphorus across Ontario as an alternative to conventional technologies. TPM can be applied in areas where background phosphorus levels exceed the Provincial Water Quality Guideline of 0.03 mg/l. A Certificate of Approval for conventional expansion requires zero increase in phosphorus loadings. Under TPM, provincial treatment standards still apply to the increased discharge, including a maximum 1.0 mg/l phosphorus concentration.

Phosphorus degradation is extensive in the South nation with levels sometimes exceeding the PWQG by more than five times. Studies show that over 90% of the phosphorus is from non-point sources, including stormwater runoff from farm fields, barnyards, golf courses, urban area, and streambank erosion.

Six of the sixteen municipal lagoons in the South Nation watershed are considering expansions. These dischargers may evaluate TPM as an option along with conventional technology through the Environmental Assessment process. The municipality or industry would be responsible through their Certificate of Approval to ensure that four times the amount of phosphorus

contained in the increase or new wastewater stream is eliminated from entering surface water through the implementation of non-point source projects within the watershed. Currently, the SNC is implementing TPM strategy for three watershed municipalities and industries. TPM avoids millions of dollars in costs to achieve a zero increase in phosphorus loading through conventional technology. The same type of trading system could be used for other parameters of concern, targeting appropriate non-point sources. South Nation Conservation research shows that the cost of removing phosphorus is $2,000 to $3,000 per kilogram using conventional wastewater treatment. By using TPM practices such as buffer strips, and milkhouse washwater treatment, costs are reduced to $300 per kilogram. Focusing on non-point sources of phosphorus results in the greatest reduction for the lowest cost. Although the TPM program documents the resulting reduction in phosphorus, the projects provide many additional benefits, including reduced bacteria, nitrogen, sediment pesticide runoff, fish habitat improvement, water quantity reduction, etc.

Participating municipalities and industries enter into an agreement with South Nation Conservation (SNC) to deliver TPM funds through the SNC's Clean Water Program. SNC currently has signed agreements with three local municipalities to deliver TPM funds, beginning in 2000. In addition, Parmalat, a local dairy industry, voluntarily contributed $150,000 to the SNC Clean Water Program over 3 years to reduce phosphorus loadings through non-point source projects. The funding successfully completed 22 voluntary non-point source projects that reduce the annual phosphorus loading to the South Nation River by 777 kilograms.

SNC's Clean Water Program provides grants to landowners for water quality improvement projects. All projects are voluntary, include financial incentives, and are approved by the SNC Clean Water Committee. The Clean Water Committee is a multi-stakeholder group responsible for the development and implementation of the Clean Water Program. Committee membership includes local farmers, agricultural organizations, Provincial agencies, municipalities, industry and SNC.

SNC documents phosphorus load reductions through a water quality monitoring network and phosphorus algorithms. A watershed computer model assists with targeting the TPM funds to the high priority locations within the watershed where phosphorus reductions will be most effective at improving watershed water quality.

North Castor Watershed Water Quality Study

The Clean Water Committee is undertaking a water quality study, which uses a computer model to assist with watershed management decisions. This study has the potential to greatly enhance surface water quality within the North Castor watershed.

Why the North Castor Watershed?

The North Castor watershed is characteristic of the South Nation watershed and much of Eastern Ontario with respects to soils, landscape, and land management practices. A large portion of what is learned and implemented in this study can easily be applied to the whole watershed and will facilitate in the transfer of technology to other Conservation Authorities.

What is the benefit of a Computer Model Watershed Study?

The computer model will be used to test the impact of selected land management practices on water quality. This will enable the Clean Water Committee to focus money and resources on the projects that will show an accelerated improvement in water quality and that are cost effective. The study allows for the involvement of residents, businesses, and agencies in watershed management planning. The results of this study should benefit both urban and rural residents with improved water quality for residential use, commercial use, recreation, and wildlife habitat.

How does the Computer Model work?

The Computer model was originally developed by the US Department of Agriculture and further enhanced for use in Ontario by the Ministry of the Environment and the University of Waterloo. The model considers the impact on the water from the non-point sources (e.g. urban storm water, natural stream bank erosions, waste water discharges, nutrient runoff, construction sedimentation, etc.) It considers all variables affecting water quality including: soils, land slope, nutrient inputs, land management practices, precipitation, drainage sediment inputs, erosion, existing water quality, etc. The computer model output provides a picture of the watershed in terms of high, medium, and low contributors of sediment and nutrient loading. Various project scenarios can then be tested using the model to determine the most effective method of improving water quality.

What are the Project Components?

A major component of the North Castor Watershed Study will involve the collection of background information on nutrient use, land management practices, and current water quality. This summer the Clean Water Committee will conduct a survey with the help of the watershed residents and businesses to determine local nutrients use trends and land management practices. Residents will also help in the calibration of the computer model through validation of data. To determine the current state of water quality within the watershed, a monitoring station has been established on the North Castor River. Samples collected during the rainstorms will test water quality for sediment and nutrient levels. Temperature, precipitation, and water levels are also recorded. Water quality data collected will also be used as a baseline to determine the effectiveness of current and future water quality projects.

III) Grand River Regional Groundwater Study

The Grand River Conservation Authority has long recognized that ground water is an integral component of the hydrogeological environment of the Grand River watershed. roundwater is critical in providing baseflow to many parts of the watershed, thereby supporting the watersheds aquatic ecosystems.In addition there are numerous communities ithin the watershed that rely on groundwater supplies for their drinking water requirements. n recent years it has been recognized that the quality of mapping and understanding of groundwater flow conditions across the watershed was inadequate for making appropriate land use decisions by conservation authority staff. In addition most of te available mapping provided little direction in terms of delineating areas that might be critical in achieving a better understanding of the links between the ground and surface water systems.

A study was undertaken to comprehensively investigate the hydrological regime within the Grand River watershed. Taking advantage of recent database management and GIS technologies, a key gol of the study was to produce a series of interpretive maps that could be used to better understand the overall Grand River watershed groundwater system particularly the linkage between the groundwater and surface water systems.The mapping has made extensive use of the Ministry of the Environment's water well record database, which was updated by the GRCA which included all wells drilled up to the end of 1998. The Ontario Base Mapping obtained from the Ministry of Natural Resources was also used extensively to produce the maps. The ultimate goal of the maps and the final report is to make more effective land use decisions within the watershed.

IV) Essex Region Conservation Authority Purpose Built Biofiltration Wetlands

Several "Purpose Built Biofiltration Wetlands" have been constructed over the years. For example, one was constructed on the Unholzer property (Belle River watershed) in 1994 using CURB funding to treat milkhouse waste. Another project, presently being completed in the Canard River watershed, receives runoff from the surrounding agricultural areas and high flows from the Canard itself."

V) Computer Models Used within the Lake Simcoe Watershed

The Lake Simcoe Conservation Authority has been using the Agricultural Non-Point Source Pollution (AGNPS) and the Hydrologic Simulation Program - Fortran (HSPF) computer models to assist in assessing the contribution for phosphorus from non-point sources within our watershed. The following is a brief description of the models and their capabilities.

Agricultural Non-Point Source Pollution (AGNPS) Model

AGNPS is an event-based, watershed-scale model. The model simulates surface runoff, sediment, chemical oxygen demand (COD) and nutrient transport primarily from ungaged agricultural watersheds of up to 20,000 ha. Nutrients considered include nitrogen (N) and phosphorus (P) (Dillaha, 1990; CEE/QDU, 1998).

In addition, it is possible to simulate the addition of point sources of wastewater, sediment, N, P, and COD from animal feedlots, water impoundments, wastewater treatment plants and springs (CEE/QDU, 1998).
The model operates on a square cell basis with all 22 model inputs expressed at the cell level. Accuracy and input requirements are directly related to the selection of cell size, from 2.5 to 40 acres. Data file creation can be time consuming and tedious although much of the input data is easily acquired.

Pollutants are routed from the source cell, through intervening cells to the watershed outlet (Dillaha, 1990). The model has the ability to output water qu characteristics at intermediate

points throughout the watershed network (CEE/ODU, 1998). This feature facilitates the identification of critical source areas and the opportunity to evaluate remedial alternatives.

As documented by CEE/ODU (1998) the model utilizes equations and methodologies that have been well established and are extensively used by agencies such as the USDA Soil Conservation Service. The SCS runoff curve number is used to estimate the runoff volume and the peak flow rate. The empirical relationship used to estimate the peak runoff rate for each cell is the same equation that is CREAMS. Erosion and sediment transport are calculated using modified forms of the USLE and Bagnold's stream power equation.

Pollutant transport addresses sediment-bound and soluble pollutants separately. Nutrient yield in the sediment-bound phase is calculated as a function of the nutrient content of the field soil, the sediment yield, and an enrichment ratio which is a function of soil texture and sediment yield. Soluble nutrient loss is a simple function of the soil nutrient level and an extraction coefficient. AGNPS Considers only losses of total nitrogen an phosphorus and nutrient transformations are not considered (CEE/ODU, 1998).

Dillaha (1990) documents that model testing of runoff estimation has occurred for 20 watershed in the north United States and there are 4 watershed where testing is being conducted in Ontario. The results indicated that peak runoff rates were approximately 1.6% less than observed values with a coefficient of determination of 0.81. Sediment yield predictions compared favorably with observed sediment yields from two watersheds in Iowa and Nebraska. Furthermore, although the nutrient model has not been adequately tested, limited testing in Minnesota watersheds indicated that the model provides realistic estimations of nutrient concentrations in runoff. The model's effectiveness in predicting total runoff volume was not reported by the CEE/ODU and it is therefore difficult to assess the ability of the model to predict total yields. Initial estimates being completed in the Lake Simcoe watershed indicate the model is providing realistic estimates for total yields.

The model is available for free from several web sites including the CEE/ODU Model Library (1998). AGNPS is written in C, FORTRAN and Pascal and operates on DOS computers. Furthermore, because AGNPS is spatially explicit the data is linked to a GIS (CIESIN/USDA, 1994).

Hydrologic Simulation Program-FORTRAN (HSPF) Model

HSPF is a continuous, watershed-scale model developed to simulate the movement of dissolved oxygen, BOD, organic matter, temperature, pesticides, nutrients, salts, bacteria, sediment, pH, and plankton from the land surface through streams, reservoirs, and groundwater (Dillaha, 1990). This is the only comprehensive model of watershed hydrology and water quality that allows the integrated simulation of land and soil contaminant runoff processes with in-stream hydraulic, water temperature, sediment transport, nutrient, and sediment-chemical interactions (ESS, 1996; CEE, 1998). Furthermore, both point and NPS sources can be simulated in HSPF. This allows comparisons between the relative magnitudes of point and NPS pollution during water quality planning (Dillaha, 1990).

HSPF is an improved version of the ARM model. HSPF simulates watershed diversity by subdividing the watershed into land segments with relatively uniform meteorological conditions, soils, crops, and management practices (Dillaha, 1990). Runoff from the land segments drains to channel reaches with uniform hydrologic properties and to larger receiving waters if they exist. It is difficult to include many land segments in the model because increasing their numbers greatly increases calibration and input data requirements.

The result of this simulation is a time history of the runoff flow rate, sediment load, and nutrient and organic chemical concentrations, along with a time history of water quantity and quality at any point in a watershed. HSPF simulates three sediment types in addition to three organic chemicals (or one chemical and 2 transformation products of that chemical). The transport and reaction processes included are hydrolysis, oxidation, photolysis, biodegradation, volatilization, and sorption (ESS, 1996; CEE, 1998; Ambrose and Barnwell, 1989).

HSPF is a large model requiring formal training, several years of historical hydrologic records for calibration, extensive databases, and large computer resources (Dillaha, 1990, ESS, 1996). For example, as a continuous simulation program, continuous rainfall records are required to drive the runoff model and additional records of evapotranspiration, temperature, and solar intensity are desirable. A large number of model parameters can be specified, although default values are provided where reasonable values are not available (ESS, 1996).

Dillaha (1990) references a useful publication to help in selecting model parameters for simulating agricultural BMPs. However, as a consequence of calibration requirements and the lumped parameter approach it difficult to use HSPF to evaluate changing watershed conditions caused by BMP implementation.

HSPF is probably the most used NPS model. There have been hundreds of applications of HSPF all over the world from experimental plots of a few acres to the largest application in the 62,000 square mile tributary area of the Chesapeake Bay. However, more so than other NPS models, HSPF has received very little independent verification and should be used with caution (Dillaha, 1990). The model is available from the National Technical Information Service (NTIS), in Virginia and supporting documentation is also readily available (ESS, 1996).

VI) Mapping the Water Quality of Kettle Creek from Satellite Imagery & Rehabilitating a Wetland in Dodd Creek Sub-basin

This program will address two essential aspects of water management in Kettle Creek basin: First, the production of a map showing the current distribution of water quality throughout the basin, and the main cause of water quality impairment in various reaches of the Dodd Creek sub-basin, that will provide the foundation for water quality management in the basin. Second, the long-term retention, enhancement and rehabilitation of a wetland in Dodd Creek that will provide spring storage of water, spawning and rearing habitat for warm-water fish and public access for wildlife viewing and environmental education.

An innovative project at Kettle Creek Conservation Authority is tied into state-of-the-art technology. In partnership with the University of Guelph and Green Lane Environmental Inc., the Authority is in possession of multispectral photographs taken from space by a French

satellite. the images show the condition of all watercourses in the watershed, pinpointing current and future trouble spots where water quality is a concern. The leading edge technology is enabling the authority to pinpoint future areas for tree planting and watercourse protection.

VII) Perth County Groundwater Recharge Study

The County of Perth relies almost exclusively on groundwater to provide drinking water to residential users and to service its industrial, commercial and institutional sectors. In a well water survey completed by the Perth County Health Unit in 1991 approximately 38% of the wells surveyed had some form of contamination with the majority being bacterial in nature. Concerns of possible impacts on our groundwater resources continue with respect to livestock nutrient contamination, industrial impacts and private septic systems. A more thorough understanding of the susceptibility of groundwater to contamination and a strategy to ensure protection is required to provide for a safe and secure water resource for the future.

This study is being completed in cooperation with the municipalities within the County of Perth, the Ausable- Bayfield, Grand River, Maitland Valley and Upper Thames River Conservation Authorities, the Perth District Health Unit and the Ministry of Environment.

Goals of this study include:
i) identification and delineation of groundwater recharge and discharge zones throughout the County,
ii) modeling and mapping of zones of groundwater sensitivity to contamination,
iii) a contamination assessment of the groundwater resource,
iv) a long term monitoring program that would assess both quality and quantity, and
v) development of a groundwater protection strategy that could be used county wide.

VIII) CA Monitoring Programs

Conservation Authorities are involved in a great deal of environmental monitoring across their watersheds. The following highlights some of the monitoring data that can be found at numerous CA's.

Benthic Monitoring

Benthic monitoring which determines the health of streams through the analysis of "bug life" living in the substrate is done at a number of Authorities across the province. Monitoring ranges from a few selected sites to upwards of 100 monitoring stations annually.

Fisheries Monitoring

Electrofishing is completed in numerous streams and drains across the province to determine health and specie diversity. Assessments can include species type, number and size.

Provincial Water Quality Monitoring Network

In conjunction with the Ministry of the Environment (MOE), a number of Conservation Authority's have been collecting water quality samples stations throughout their watersheds with some historical data going back to the 1960's. Analysis includes both chemical and metal parameters and allows for the development of long term water quality trends at these stations.

Provincial Groundwater Monitoring Network

Conservation Authority's are working cooperatively with the Ministry of the Environment to establish a provincial groundwater monitoring network. This network will see a number of monitoring wells established across the province which will provide ambient water levels and quality conditions. This monitoring is slated to get underway in 2001.

APPENDIX V
GLOSSARY OF ACRONYMS

Agencies / Associations / Centres / Departments	
AAFC	Agriculture and Agri-Food Canada
ARIO	Agriculture Research Institute of Ontario
CARC	Canadian Agri-Food Research Council
EC	Environment Canada
ECORC	Eastern Cereal and Oilseed Research Centre, AAFC Ottawa
GPCRC	Greenhouse and Processing Crops Research Centre, AAFC Harrow
KCAT	Kemptville College, University of Guelph
LRS	Land Resource Science Dept., University of Guelph
MOH	[Ontario] Ministry of Health
NWRI	National Water Research Inst., Environment Canada
OCPA	Ontario Corn Producers Association
OCSRE	Ontario Centre for Soil Resource Evaluation
OIP	Ontario Institute of Pedology
OLRU	Ontario Land Resource Unit, Agriculture and Agri-Food Canada (closed 1998)
OMAFRA	Ontario Ministry of Agriculture, Food and rural Affairs
OME	Ontario Ministry of the Environment (see also OMEE)
OMEE	Ontario Ministry of the Environment and Energy (see also OME)
OMNR	Ontario Ministry of Natural Resources
OSCIA	Ontario Soil and Crop Improvement Association
PFRA	Prairie Farm Rehabilitation Administration

Agencies / Associations / Centres / Departments	
SCPFRC	Southern Crop Protection and Food Research Centre, AAFC London
U of G	University of Guelph
USDA	United States Department of Agriculture
US EPA	United States Environmental Protection Agency

Committees	
ARSC	Animal Research & Services Committee
BUC	Biosolids Utilization Committee
OASCC	Ontario Agricultural Services Coordinating Committee
OARSC	Ontario Agrometerology Research and Services Committee
OERSC	Ontario Economics Research and Services Committee
OFCRSC	Ontario Field Crop Research and Services Committee
OFPRSC	Ontario Food Processing Research and Services Committee
OSMRSC	Ontario Soil Management Research and Services Committee
OSWARSC	Ontario Soil, Water and Air Research and Services Committee
ORCDRSC	Ontario Rural Community Development Research & Services Committee
OWMRSC	Ontario Water Management Research and Services Committee

Programs	
CURB	Clean Up Rural Beaches [Program] - OMEE
GLWQP	Great Lakes Water Quality Research Program (Agriculture Canada)
HEMS	Hog Environmental Management Strategy (AAFC)
NSCP	National Soil Conservation Program (Agriculture Canada)
NSWCP	National Soil and Water Conservation Program
OREP	Ontario Research Enhancement Program
PINUE	Partnerships in Nitrogen Use Efficiency (Water Quality Working Group)
SWEEP	Soil Water Environment Enhancement Program

Terms	
BMP	Best Management Practice
DSS	Decision Support System
EDC	Endocrine disrupting compound
EFP	Environmental Farm Plan
GHG	Greenhouse gas
GIS	Geographic Information System
GPS	Global Positioning Units
IROWC - N, -P	Indicator of Risk of Water Contamination - for N, - for P
McCLONE3 NMAN98	Computer Manure/Nutrient Management Programs
NMP	Nutrient Management Plan
NPS	non-point source
SSCM	Site-Specific Crop Management

APPENDIX VI

Provisional Committee Meeting Dates - 2001

Committee	Location	Dates
OASCC	OMAFRA, Guelph	February 28
OSWARSC	OMAFRA, Guelph	November 22 - 23
OARSC	OMAFRA, Simcoe	November ?
OSMRSC	London area	June 12 – 13
Field Crops	OMAFRA, Guelph	February 27
Horticultural Crops	Woodstock	March 20 (tentative)
Soil and Water Quality	OMAFRA, Guelph	February ?
Soil Test Lab	Guelph	May 25
Waste Utilization	Husky Farm Equipment, Alma, ON	March 2 (tentative)
Tobacco	Delhi	April
OWMRSC		Aug or Sept.